VOL. 26 NO. 9

BULLETIN

OF THE

TORREY BOTANICAL CLUB

SEPTEMBER 1899

The Effect of Chemical Irritation on the Economic Coefficient of Sugar

HERBERT MAULE RICHARDS

It has been known since Raulin's* account of the nutrition of fungi that certain metallic salts—notably those of zinc—induce a more rapid growth of fungi than is normal, although, as has been shown by more recent work,† he somewhat misinterpreted the action of these salts. It is now well known, as has been demonstrated by many competent experimenters, that a much simpler nutrient solution than was thought necessary in Raulin's time is adequate for an entirely normal development of fungi. With some available source of carbon and nitrogen it is only necessary to add salts containing potassium, magnesium, sulphur, phosphorus, and a trace of iron to provide a suitable substratum for the growth of these saprophytic hyphomycetous fungi which have been experimented with.‡ The action of the metallic salts noted by Raulin, as well as of others not considered by him, is to be regarded as a response to a chemical irritation which in some way hastens the metabolic activity of the fungus. The result is the production within a given time of a greater amount of dry substance as compared with the same fungus grown under similar conditions, but on solutions free from the irritant. For further particulars as to the range of substances which affect this abnormal growth and

* Études Chimique sur la Vegetation, Ann. d. Sc. Nat. Bot. V. 11 : 91. 1869.

† Die Beeinflussung des Wachsthums einiger Pilze durch chemische Reize. Richards, Prings. Jahrb. 30 : 665. 1897.

‡ Pfeffer, Pflanzenphysiologie, 1 : 374.

[Issued September 22.]

the comparative violence of the irritation, reference is made to the paper already cited.* It will be seen that numerous metallic salts and some organic substances were found which more or less markedly bring about the above noted effect and that their action is constant, although the organic substratum, or the nitrogen source, be changed. Iron salts have a double effect, acting in the first place as a necessary substance for the growth of fungi,† and in the second place in stronger solutions having a distinctly irritating effect.

It was the object of the following recorded experiments to endeavor to throw some light on the physiological action of this chemical irritation, to approach a little nearer to discovering the underlying cause of the abnormal growth of these fungi under such conditions. As a first step in this direction cultures and analyses were made to determine if there was any regular and considerable variation in the economic coefficient of the organic food material supplied to the fungus.

Because of its greater ease in determination sugar was employed as the organic basis of the nutrient solution and many analyses were made to determine what relation the weight of dry substance produced for the amount of sugar used bore between the normal culture, and those growing under chemical irritation. It would, no doubt, have been interesting for further comparison to have used other organic substrata, such as glycerin, but it was hardly necessary in this instance to do so in order to prove the point desired, and the difficulty of accurate quantitative determination of glycerin made it impracticable with the facilities at hand for such research.

For the cultures the usual method of growing the fungi in flasks was employed. For most of the experiments the ordinary Florence flasks of about 125 cc. capacity were used; they were selected with due care as regards similarity of shape, and any error due to difference in area of the surface of the culture fluid could not have been considerable. In these flasks 50 cc. of the nutrient solution was used; for larger quantities, where 100 cc. was taken, Erbenmeyer flasks of Jena glass, about 250 cc. in capacity,

* Richards, *l. c.*

† Molisch, Pflanze in ihren Beziehungen zum Eisen. Jena, 1892. Benecke, Die zur Ernährung der Schimmelpilze nothwendige Metalle. Prings. Jahrb. 27: 487. 1895.

were selected. The sowings of the fungus spores were not made by the addition of water in which the spores hung suspended, since it was desired not to weaken the solutions and thereby involve another chance of error in the subsequent analyses. Instead of this method, small pieces of heavy glass rod (about 8 mm. diam.) were taken, their ends slightly moistened and then rubbed on the dry stock culture of the desired fungus. The bits of glass rod, with the attached spores, were then dropped in the prepared flasks; a slight shaking served to dislodge the spores which promptly rose to the surface and with sufficiently even distribution to insure an even growth of the fungus when they germinated. In this way the cultures were provided with at least an approximately equal number of spores, certainly above the maximum required to produce an unbroken carpet of mycelium, and that, as has already been shown, is sufficient to make an equal growth on surfaces of the same area.

As in the previous investigations the greatest care was taken to have all of the substances used for the culture fluids of the greatest practicable degree of purity. The chemically pure salts prepared by Merck & Co. were used and again recrystallized. The sugar was of the best quality obtainable in the market and showed on many tests to be free from impurities. The water was twice distilled, once over a tin-lined still and the second time over glass with alkaline permanganate. It should be added that due care was taken that none of the permanganate passed over. By all tests employed as well as by the evidence of the experiments themselves, the water was shown to be pure. For the irritant substances, the zinc sulphate and lithium carbonate, from which the chloride was prepared, were kindly given the writer by Professor T. W. Richards, of Harvard University. Of the other salts the nickel sulphate and the ferric chloride were the purest obtainable and further purified by successive recrystallizations.

Only one nutrient solution was used—that recommended by Pfeffer * which is identical with solution *A* of the writer's previous paper.† The formula is as follows:

* Election organischer Nährstoffe. Prings. Jahrb. **27**: 238. 1895. Pflanzenphysiologie, **1**: 375.

† Richards, *l. c.* p. 667.

NH_4NO_3	1.00
KH_2PO_4	.50
$MgSO_4$	.25
Sugar	5.00
Water	100.00
Trace of iron	

The fungi experimented with were *Sterigmatocystis* (*Aspergillus*) *nigra*, *Penicillium glaucum* and *Trichothecium roseum*.

In making up the solutions it was found most convenient as well as most accurate to prepare them in considerable quantities with all the ingredients except the sugar and of exactly twice the strength desired. Of the solutions thus prepared and with their respective amounts of the irritant substances added, 25 or 50 cc. were taken and exactly the same amount of an accurately prepared 10% sugar solution added. In all of the processes the same pipettes were used throughout and were handled in the same manner, great care being taken of course not to contaminate one solution with another, particularly the control solutions. In this manner it was found practicable to prepare quickly solutions containing a standard of 5% sugar with all the accuracy needed for this work. Numerous test analyses were made of solutions made up after this manner and it was found that they did not vary more than 0.005 grm. in sugar content. It is obvious that it was needful to have confidence in the accuracy of the solutions for upon this point depended the entire result of the work.

When the crop of fungus was harvested the flasks were well shaken and the contents filtered. To the filtrate 1 cc. of a 5% solution of HCl was added and time being allowed for the inversion of the sugar the HCl was then neutralized with Na_2CO_3 and a sufficient amount of water added to dilute the solution to just twice its original bulk, thus weakening it sufficiently to allow of an accurate analysis. From these solutions always two and sometimes more analyses were made. The control cultures were usually two in number; the average between them being the figures printed in the tables. The determination of the sugar was made by the Fehling method. For this purpose the usual solutions of $CuSO_4$ and of alkaline Rochelle salts were made up and mixed freshly for each set of analyses. The Fehling solution was tested against a

standard sugar solution each time. The factor (Allen's Industrial Chemistry, vol. I., p. 226) of 10 cc. Fehling solution = 0.0475 cane sugar after inversion was used as the basis of all calculations.

The dry weight of fungus was determined in the usual way, the crop having been collected on a weighed filter was dried in an oven at the temperature of about 70° C. to constant weight.

In the absence of thermostat the cultures were grown at the ordinary room temperature in the laboratory or at a somewhat higher temperature in a room which served also as a conservatory. The cultures were consequently subjected to some fluctuation of temperature, possibly somewhat to the disadvantage of the results obtained. It would, undoubtedly, have been preferable to have grown the *Sterigmatocystis* cultures at a point nearer the optimum for that fungus between 30° and 34° C. In the case of the *Penicillium* the room temperature approximated more nearly the lower optimum of that fungus. In spite of the variations, however, the results for both correspond satisfactorily, the *Sterigmatocystis* cultures being allowed to grow for a somewhat longer period than would otherwise have been necessary.

It would, indeed, have been well to have determined the respiration quotient in relation both to the increased growth and the economic coefficient but the writer was unable at the time to do so, although, it is his intention to experiment in this line in the future. The facts demonstrated, however, show much as to the economic coefficient of the sugar in relation to the abnormal growth caused by chemical irritation despite the fact that at present they cannot be compared with the CO_2 coefficient.

It will be seen by comparison with the results of Kunstmann* that the averages of the economic coefficient obtained from the control cultures is correct. This average approximates 2.00 for the ratio between the amount of sugar used for the dry weight of fungus produced or, as may better be expressed, 0.50 grm. of dry substance for each gram of sugar consumed. In table I. of Kunstmann's paper the average coefficient for those cultures grown between the temperatures of 17° and 25°C. is 2.05 = 0.49. This serves as a check for the results recorded herein.

* Ueber das Verhältniss zwischen Pilzernte u. verbrauchter Nährung. Inaug. Dissert., Leipzig, 1895.

Taking the control cultures as a base from which comparison can be made, those cultures to which an irritant substance was added now demanded attention. From the results previously obtained such degrees of concentration as showed a marked irritant were employed, the stronger solutions where in the case of the poisonous salts a secondary toxic effect was noted, were not employed, except in one series. With this last named exception all of the $ZnSO_4$ series comprised the following percentages of the anhydrous salt 0.002 %; 0.004 %; 0.008 %; 0.032 %; the last named concentration being just within the range of the toxic effect. In those cultures to which iron salts were added, a much greater degree of concentration is indicated, for it will be remembered that iron has a double effect, first as a necessary food substance for the fungus, and secondarily, when present in larger quantities as an irritant. Consequently the percentages of Fe_2Cl_6 were 0.05 %; 0.10 %; 0.20 %. In the same way the lithium salt, in this case lithium chloride, although not an indispensable ash constituent is not effective as an irritant, except in comparatively strong solutions, and apparently does not exert any poisonous influence on these hyphomycetous fungi. It was used in the following concentrations of 0.125 %; 0.350 %; 0.375 %. In the few series with nickel salts the sulphate was not used in concentrations very much greater than with the $ZnSO_4$, for like the latter salt it is ultimately a poison. The citations above given are in fractions of a per cent., for the sake of comparison with the writer's previous paper which has already been referred to, but it will be observed that in the tables the equivalents of the solutions are given in fractions of the *normal* solution. This method of reckoning in gram-atoms of the irritant or toxic base was employed by Kahlenberg and True* and affords a much better standard for comparison for future works in this line than expressions in terms of per cent. Since in every salt used in these experiments herein described the acid may be regarded as entirely neutral in its effect on the growth of the fungi the whole of the irritant effect is to be referred to the base of the particular salt employed.

Upon examination of the tables it will be seen that the curve of the economic coefficient of the sugar rises with the increase in

* Bot. Gaz. **22**: 81–124. 1896.

the dry weight of the fungus, but more abruptly. For instance, in the case of the cultures with $ZnSO_4$ as in the case of irritation it attains its maximum of 0.58 (see general averages, Table V.) at a concentration of 0.004% of this salt, at which point also the maximum weight is shown. In solutions of greater strength the coefficient falls off but more rapidly than does the abnormal growth. At a concentration of 0.032% when the toxic effect of the $ZnSO_4$ begins to be noticeable the economic coefficient has fallen almost to that of the control as also has the weight of dry substance. In yet stronger solutions in which the growth is much retarded the amount of sugar used remains, however, in about this same relation. The cultures in which Fe_2Cl_6 was used do not show the same regularity. Up to the strength of 0.1% the rise of the economic coefficient of the sugar from 0.46 to 0.56 keeps pace with the increase of weight from about 330 mg. to 800 mg. and agrees with the results found with the $ZnSO_4$, but beyond that at a concentration of 0.2% the average of the economic coefficients falls somewhat while the average weight of the fungus crop increases. This was more apparent in the *Penicillium* cultures than in those with *Sterigmatocystis*. In the latter both the weight and ratio remain about equal, while in the *Penicillium* only one series shows any increase (XVIII.) and series XX. indicates a distinct falling off of the coefficient although a considerable gain in weight is shown in the 0.2% culture over that with but 0.1% of Fe_2Cl_6. It is to be observed, however, that in this case the ratio of 0.82 given for the 0.1% culture stands alone in being the highest found in any series. It is this series that has so materially affected the averages, but since no legitimate reason could be discovered for throwing it out it was necessarily included with the rest. In the series with LiCl the two with *Sterigmatocystis* show the same peculiarity, for in the stronger concentration of 0.375% there is a distinct gain in weight with some falling off in the availability of the sugar consumed (series XXII., XXIII.). In the *Penicillium* cultures the ratio rises even in the strongest solution employed but at 0.375% the gain does not correspond to the increase in weight over the 0.25% concentration. In the *Trichothecium* series there is no marked change. All of the series with LiCl agree, however, in showing in the weaker solutions of 0.125% and 0.25% an increase of the

ratio over that found in the control cultures corresponding to that found in other experiments. A few series were tried with a nickel salt, the results falling in line with those obtained with the $ZnSO_4$ cultures, the curve of the economic coefficient of the sugar following a course similar to that of the gain in weight.

In order to compare the abnormal growth caused by these inorganic salts with that produced by organic substances a couple of series were carried through with cocaine as an irritant. As is shown in the previous paper these fungi do not respond very violently to the organic substances therein mentioned and cocaine was selected as being the most potent. The results were surprisingly definite; as will be seen a distinct increase of weight resulted with also an appreciable gain in the ratio amounting to about 0.04.

It will be seen that, although the effectiveness of sugar as a source of organic nutrition increases in general with the increase of growth induced by the irritant substance and diminishes as the latter diminishes, the economic coefficient does not exactly parallel in its curve the gain of dry substance. For instance, supposing that the dry weight of a control culture be 1 and the economic coefficient of the sugar be 0.50, although the dry weight of a culture under similar conditions but with the addition of an irritant be 2 the economic coefficient is not 1.00 but much lower on the average, say 0.60. Indeed, it is not to be expected that the economic coefficient should vary in the same proportion as the increase of weight. Such an example as given above—the ratio of weights is often higher as much as 1 to 3—would require that *all* of the sugar used be available for the production of the fungus mycelium, an impossibility in any event since such a condition would preclude the respiration of any CO_2. Nor is it necessary that the available portion of the sugar used increase in a similar proportion to the dry substance, for it will be remembered that the effect of the irritant substance must, as long as the food supply is not greatly exhausted, be cumulative. Even a smaller increase of the economic coefficient of the sugar than that absolutely found would serve to account for a considerable increase in weight. It is evident from the experiments that of the sugar used more is actually available for the fungus and that provides for and implies a more rapid growth of the latter. Granting this together with the accompanying

necessity that the irritant substance is acting continually, it is easy to understand that any gain in weight might be indefinitely multiplied as long as the food supply was sufficient. Since, up to a certain point, the economic coefficient of the sugar rises with the increase of dry weight shows that there must be some relation between the two, that the latter phenomenon must in some measure at least be dependent upon the former. The actual gain in the economic coefficient must at any one time be very small and it is highly probable that given time any two cultures, the one with and the other without an irritant substance added would tend to become equalized.

As the weight of the crop falls with the increase of $ZnSO_2$ so also does the economic coefficient diminish, but the writer would not be prepared to maintain that the toxic effect of this substance is in itself merely the diminishing of the economic coefficient to a vanishing point. It is not to be supposed that the irritant salt acts directly on the sugar but on the fungus in which no doubt other and more subtle changes in the protoplasm are brought about. As was shown indeed in one series even in very much stronger solutions of $ZnSO_4$ where the growth is materially diminished by the salt, the economic coefficient remains practically the same as in the normal. A further discussion of the *toxic* action of this salt is, however, not within the limits of this paper.

While it would be manifestly improper with evidence afforded by only a comparatively few series of experiments from but a single point of view to theorize too widely as to the nature of this chemical irritation, the writer feels justified in arriving at the conclusion that the increase in the availability of the sugar consumed is at least one factor and an important one in determining the increase of growth. In just what way the irritant influences the metabolic activity of the fungus hyphae must be at present at least merely a matter of speculation. The irritant substance is not in itself a source from which energy is available.

In their action as poisons the salts of zinc, nickel, manganese and lithium would come under the third group of poisons as recognized by Loew in his "Naturliche System der Gift Wirkungen,"* which includes those bases that by their power of forming salts with the protein substances of the protoplasm induce disturbances

* Munich, 1893. See also Davenport, Experimental Morphology, 1 : 12.

which ultimately end in death. It may be that such indeed is the case, but the poisonous substances so formed being in such minute quantities, owing to the dilute solutions used, do not serve to kill the protoplasm, but merely stimulate its molecular activity in an endeavor to throw off the irritant substance, or to induce what might be called a secondary katalytic action. The results with the salts of iron which are not poisonous do not, however, uphold such a view, yet it is not impossible that in stronger solutions the apparently inocuous base, iron, might prove to exert a poisonous influence. This might be impossible to demonstrate, since the necessary concentration to produce any deleterious effect would be so great as to confuse the results with the osmotic action of the solution. If it is not possible to admit any such semi-toxic action on the part of the irritant substances, it is necessary to fall back upon the idea of their action being strictly katalytic, as suggested by Pfeffer,* or simply to include the phenomenon under the comprehensive phrase "physiological counter-reaction."

The results of these experiments may be briefly stated as follows:

That the direct action of irritant substances (in this case inorganic salts), which produce an increased growth of certain fungi is to enable the latter to dispose more economically of the sugar used (*i. e.*, to raise the economic coefficient of the sugar) thereby permitting a more rapid production of dry substance in a given time.

That the increase of the economic coefficient is not in proportion to the percentage increase in weight.

That the economic coefficient again decreases when in poisonous substances the maximum of growth is passed, but that it apparently does not ever fall much below the normal.

This work was begun in the Cryptogamic Laboratory of Harvard University in 1897–98 and completed at Barnard College, New York, in 1898–99. The writer would here express his thanks to Professor H. B. Hill, Director of the Chemical Laboratory of Harvard University, for his courtesy in allowing the use of the facilities of that laboratory.

NEW YORK, May, 1899.

* Pfeffer, Prings. Jahrb. **28**: 238. 1895.

TABLE I.

In all of the cultures a standard of 5% sugar was used. The series are indicated in Roman numerals.

I. *Sterigmatocystis nigra*. $ZnSO_4$ added. Grown at room temp. about 20°C. Harvested one week after sowing.

% $ZnSO_4$. Fraction normal $ZnSO_4$.	Control.	.002% .000125	.004% .00025	.008% .0005	.032% .002
I.					
Weight crop mg.	535	846	1020	945	
Sugar used mg.	930	1220	1400	1315	
Sugar residue mg.	1570	1280	1100	1185	
Econ.) Fungus : sugar.	1.74	1.44	1.37	1.39	
Coeff. (Sugar : fungus.	0.57	0.69	0.73	0.72	
II as in I.					
Temp. about 20°C. 7 days.					
Weight crop mg.	640	912	1104	842	800
Sugar residue mg.	1845	1315	1300	1370	1305
Sugar used mg.	955	1185	1200	1130	1195
Econ.) Fungus : sugar.	1.49	1.29	1.09	1.34	1.50
Coeff. (Sugar : fungus.	0.67	0.77	0.92	0.75	0.67
III as in I.					
Temp. about 20°C. 6 days.					
Weight crop mg.	330	535	817	800	400
Sugar residue mg.	1825	1605	1320	1284	——
Sugar used mg.	675	895	1180	1216	——
Econ.) Fungus : sugar.	2.00	1.67	1.44	1.52	——
Coeff. (Sugar : fungus.	0.49	0.59	0.69	0.66	——
IV as in I.					
Temp. circa 24°C. 8 days.					
Weight crop mg.	510	830	943	912	615
Sugar residue mg.	1306	1164	1029	1032	1461
Sugar used mg.	1194	1336	1471	1468	1039
Econ.) Fungus : sugar.	1.95	1.73	1.56	1.61	1.69
Coeff. (Sugar : fungus	0.51	0.59	0.64	0.62	0.59
V as in I.					
Temp. circa 24°C. 5 days.					
Weight crop mg.	305	523	610	600	520
Sugar residue mg.	1912	1637	1536	1540	1164
Sugar used mg.	588	863	964	960	925
Econ.) Fungus : sugar.	1.83	1.65	1.58	1.60	1.74
Coeff. (Sugar : fungus.	0.55	0.60	0.64	0.62	0.59
VI as in I.					
Temp. circa 20°C. 7 days.					
Weight crop mg.	308	527	622	580	489
Sugar residue mg.	1980	1620	1480	1525	1705
Sugar used mg.	620	880	1020	975	895
Econ.) Fungus : sugar.	2.01	1.67	1.64	1.68	1.83
Coeff. (Sugar : fungus.	0.50	0.61	0.60	0.62	0.55

TABLE II.

VII. *Penicillium glaucum*. $ZnSO_4$ added. Grown at room temperature. Harvested nine days after sowing. 100 cc. culture fluid in flasks 200 cc. capacity.

% $ZnSO_4$. Fraction normal $ZnSO_4$.	Control.	.002 % .000125	.004% .00025	.008% .0005	.032% .0020
VII.					
Weight crop mg.	430	613	940	836	503
Sugar left mg.	4093	3809	3130	3480	3500
Sugar used mg.	997	1191	1870	1520	1500
Econ. Fungus : sugar.	2.11	1.96	1.99	1.81	2.30
Coeff. Sugar : fungus.	0.46	0.51	0.50	0.55	0.46
VIII as in VII. Temp. circa 20°C. 9 days.					
Weight crop mg.	395	705	693	674	581
Sugar residue mg.	4048	3393	3409	3403	3559
Sugar used mg.	952	1607	1591	1597	1441
Econ. Fungus : sugar.	2.41	2 28	2.31	2.37	2.48
Coeff. Sugar : fungus.	0.41	0.44	0.44	0.44	0.41
IX as in VII. Temp. circa 20°C. 8 days.					
Weight crop mg.	295	416	683	618	
Sugar residue mg.	4426	4322	3873	3937	
Sugar used mg.	574	678	1127	1063	
Econ. Fungus : sugar.	1.95	1.70	1.65	1.72	
Coeff. Sugar : fungus.	0.51	0.59	0.61	0.58	
X as in VII. Temp. circa 20°C. 8 days.					
Weight crop mg.	362	700	910	685	525
Sugar left mg.	4184	3710	3453	3550	3793
Sugar used mg.	816	1290	1547	1450	1207
Econ. Fungus : sugar.	2.26	1.85	1.70	2.12	2.30
Coeff. Sugar : fungus.	0.43	0.54	0.59	0.47	0.44
50 cc.	*Trichothecium roseum.*				
XI Conditions as in VII. *Trichothecium roseum*. Harvested 10 days after sowing. Temp. circa 22°C.					
Weight crop mg.	112	203	203	196	091
Sugar residue mg.	2231	2052	2064	2013	2278
Sugar used mg.	269	448	436	447	222
Econ. Fungus : sugar.	2.40	2.21	2.15	2.28	2.44
Coeff. Sugar : fungus.	0.41	0.45	0.48	0.44	0.41
XII as in XI. *Trichothecium roseum*. Temp. circa 22°C.					
Weight crop mg.	95	205	183	194	104
Sugar residue mg.	2298	2098	2152	2126	2281
Sugar used mg.	202	402	348	374	219
Econ. Fungus : sugar.	2.13	1.99	1.90	1.93	2.11
Coeff. Sugar : fungus.	0.48	0.51	0.53	0.52	0.46

TABLE III.

XIII. *Sterigmatocystis nigra*. Excess of Fe_2Cl_6 added. Temperature about 25°C. Harvested seven days after sowing. Culture flasks 125 cc. 50 cc. culture fluid.

% Fe_2Cl_6 Fraction normal Fe_2Cl_6.	Control.	0.050% .00015	0.100% .0003	0.200% .0006
XIII.				
Weight crop mg.	320	515	710	700
Sugar residue mg.	1796	1516	1187	1205
Sugar used mg.	704	984	1313	1295
Econ. ∫ Fungus : sugar.	2.20	1.91	1.85	1.85
Coeff. ⌊ Sugar : fungus.	0.45	0.52	0.54	0.54
XIV as in XIII. Temp. circa 23°C. 6 days.				
Weight crop mg.	285	491	683	694
Sugar residue mg.	1944	1616	1346	1369
Sugar used mg.	556	884	1154	1131
Econ. ⌈ Fungus : sugar.	1 95	1.80	1.69	1.63
Coeff. ∫ Sugar : fungus.	0.51	0.55	0.60	0.62
XV as in XIII. Temp. circa 33°C. 6 days.				
Weight crop mg.	305	500	690	725
Sugar residue mg.	1890	1595	1355	1268
Sugar used mg.	610	905	1145	1232
Econ. ∫ Fungus : sugar.	2.00	1.81	1.66	1.70
Coeff. ⌊ Sugar : fungus.	0.50	0.55	0.61	0.59
XVI as in XIII, but with 100 cc. Temp. circa 24°C. 6 days.				
Weight crop mg.	711	1240	1635	1610
Sugar residue mg.	3364	2446	2028	1796
Sugar used mg.	1636	2554	2972	3204
Econ. ∫ Fungus : sugar.	2.31	2.06	1.94	1.99
Coeff. ⌊ Sugar : fungus.	0.46	0.49	0.52	0.50

TABLE IV.

XVII. *Penicillium glaucum.* Excess of Fe_2Cl_6 added. Temp. about 20°C. Harvested nine days after sowing. Culture flasks 125 cc. 50 cc. culture fluid.

% Fe_2Cl_6. Fraction normal Fe_2Cl_6.	Control.	0.051 % .00015	0.10% .0003	0.20% .0006
XVII.				
Weight crop mg.	160	300	410	390
Sugar residue mg.	2108	1837	1627	1650
Sugar residue mg.	392	663	873	850
Econ.) Fungus : sugar.	2.45	2.21	2.13	2.18
Coeff.) Sugar : fungus.	0.41	0.45	0.47	0 45
XVIII *Penicillium* as in XVII Temp. circa 21°C. 7 days.				
Weight crop mg.	148	273	386	420
Sugar residue mg.	2153	1930	1672	1647
Sugar used mg.	342	570	818	853
Econ.) Fungus : sugar.	2.31	3.09	2.12	2.03
Coeff.) Sugar : fungus.	0.43	0.46	0.46	0.49
XIX *Penicillium* as in XVI 100 cc. Temp. circa 19°C. 8 days.				
Weight crop mg.	375	830	1.012	.981
Sugar residue mg.	4128	3324	3148	3125
Sugar used mg.	872	1676	1852	1875
Econ.) Fungus : sugar.	2.30	2.02	1.83	1.91
Coeff.) Sugar : fungus.	0.43	0.49	0.54	0.52
XX *Penici lium* as in XIX 100 cc. Temp. circa 19°C. 10 days.				
Weight crop mg.	546	945	1.270	1.348
Sugar residue mg.	3890	3265	3450	2816
Sugar used mg.	1110	1735	1550	2184
Econ.) Fungus : sugar.	2 03	1.84	1.22	1.62
Coeff.) Sugar : fungus.	0.49	0 54	0.82	0.62
XXI *Penicillium* as in XIX 100 cc. Temp. circa 19°C. 9 days.				
Weight crop mg.	280	463	617	680
Sugar residue mg.	4385	4074	3891	3810
Sugar used mg.	615	926	1109	1190
Econ.) Fungus : sugar.	2.16	2.00	1.71	1.75
Coeff) Sugar : fungus.	0.46	0.50	0.58	0.58

TABLE V.

Average of $ZnSO_4$ Cultures.

% $ZnSO_4$. Fraction Normal $ZnSO_4$.	Control.	.002% .000125	.004% .00025	.008% .0005	.032% .002
Sterigmatocystis, 6 series.					
Average weight crop mg.	438	695	853	780	471
Econ. Coeff. Fungus : sugar.	1.91	1.65	1.45	1.47	1.76
Econ. Coeff. Sugar : fungus.	0.52	0.60	0.69	0.68	0.57
Penicillium, 4 series.					
Average weight crop mg.	370	650	807	707	402
Econ. Coeff. Fungus : sugar.	2 20	1.98	1.85	1.90	2.35
Econ. Coeff. Sugar : fungus.	0.45	0.52	0.54	0.53	0.44
Av. Econ. Coeff, both fungi.					
Fungus : sugar.	2.05	1.83	1.65	1.73	2.00
Sugar : fungus.	0.48	0.56	0.62	0.60	0.50

Average of Fe_2Cl_6 Cultures.

% Fe_2Cl_6. Fraction Normal Fe_2Cl_6.	Control.	.050% .00015	.10% .0003	.20% .0006
Sterigmatocystis, 4 series.				
Average weight crop mg.	316	532	725	731
Econ. Coeff. Fungus : sugar.	2.11	1.89	1.78	1.79
Econ. Coeff. Sugar : fungus.	0.48	0.52	0.56	0.56
Penicillium, 5 series.				
Average weight crop mg.	354	660	881	906
Econ. Coeff. Fungus : sugar.	2.25	2.07	1.80	1.90
Econ. Coeff. Sugar : fungus.	0.44	0.48	0.55	0.52
Av. Econ. Coeff., both fungi.				
Fungus : sugar.	2.18	1.98	1.79	1.85
Sugar : fungus.	0.46	0.50	0.56	0.54

TABLE VI.

Series with LiCl added. XXII., XXIII., *Sterigmatocystis;* XXIV.–XXVI., *Penicillium;* XXVI., *Trichothecium*. All in 125 cc. flasks with 50 cc. culture fluid.

% LiCl. Fraction normal LiCl.	Control.	0.125% .03	0.250% .06	0.375% .09
XXII. *Sterigmatocystis.* Temp. circa 24°C. 8 days.				
Weight crop mg.	295	435	420	681
Sugar left mg.	1778	1539	1580	1090
Sugar used mg.	722	961	920	1410
Econ.) Fungus : sugar.	2.45	2.21	2.19	2.07
Coeff.) Sugar : fungus.	0.41	0.45	0.45	0.49
XXIII. *Sterigmatocystis.* Temp. circa 23°C. 6 days.				
Weight crop mg.	315	451	532	610
Sugar left mg.	1892	1733	1617	1548
Sugar used mg.	608	767	833	952
Econ.) Fungus : sugar.	1.93	1.70	1.66	1.56
Coeff.) Sugar : fungus.	0.52	0.59	0.60	0.64
XXIV. *Penicillium.* Temp. circa 18°C. 9 days.				
Weight crop mg.	180	290	301	466
Sugar residue mg.	2115	1940	1964	1699
Sugar used mg.	385	560	536	801
Econ.) Fungus : sugar.	2.15	1.93	1.78	1.72
Coeff.) Sugar : fungus.	0.48	0.52	0.56	0.58
XXV. *Penicillium.* Temp. circa 20°C. 7 days.				
Weight crop mg.	135	242	288	501
Sugar residue mg.	2224	2085	2031	1712
Sugar used mg.	256	414	469	787
Econ.) Fungus : sugar.	1.90	1.71	1.63	1.57
Coeff.) Sugar : fungus.	0.52	0.59	0.60	0.61
XXVI. *Penicillium.* Temp. circa 19°C. 9 days.				
Weight crop mg.	121	264	303	285
Sugar residue mg.	2231	1964	1924	1950
Sugar used mg.	269	536	576	550
Econ.) Fungus : sugar.	2.22	2.03	1.90	1.93
Coeff.) Sugar : fungus.	0.45	0.49	0.53	0.52
XXVII. *Trichothecium roseum* Temp. circa 20°C. 8 days.				
Weight crop mg.	101	195	276	344
Sugar residue mg.	2286	2143	1986	1877
Sugar used.	214	357	513	623
Econ.) Fungus : sugar.	2.12	1.94	1.86	1.81
Coeff.) Sugar : fungus.	0.47	0.52	0.54	0.55

TABLE VII.

Sterigmatocystis nigra. XXVIII.–XXX. with $NiSO_4$. XXXI. and XXXII. with Cocaine. Otherwise as in previous cultures. 50 cc. culture fluid.

% $NiSO_4$ Fraction Normal $NiSO_4$.	Control.	0.008 % .0005	0.016 % .001	0.033 % .002
XXVIII Temp circa 24°C. 7 days				
Weight crop mg.	250	360	885	210
Sugar residue mg.	2043	1916	1156	2099
Sugar used mg.	457	584	1344	401
Econ. Coeff. Fungus : sugar.	1.83	1.60	1.52	1.91
Econ. Coeff. Sugar : fungus.	0.55	0.62	0.67	0.53
XXIX as in XXVIII. Temp. circa 24°. 7 days.				
Weight crop mg.	231	365	430	215
Sugar residue mg.	1909	1740	1714	2010
Sugar used mg.	530	760	786	490
Econ. Coeff. Fungus : sugar.	2.30	2.14	1.92	2.28
Econ. Coeff. Sugar : fungus.	0.44	0.48	0.53	0.44
XXX as in XXVIII. Temp. circa 23°. 7 days.				
Weight crop mg.	305	482	595	300
Sugar residue mg.	1835	1555	1455	1860
Sugar used mg.	665	945	1045	640
Econ. Coeff. Fungus : sugar.	2.18	1.95	1.76	2.13
Econ. Coeff. Sugar : fungus.	0.46	0.51	0.57	0.47
XXXI Cocaine, otherwise as in XXVIII.	Control.	0.1 %	0.2 %	
Weight crop mg.	360	520	600	
Sugar residue mg.	1658	1382	1192	
Sugar used mg.	842	1118	1308	
Econ. Coeff. Fungus : sugar.	2.34	2.15	2.18	
Econ. Coeff. Sugar : fungus.	0.42	0.48	0.46	
XXXII Cocaine, otherwise as in XXVIII.				
Weight crop mg.	275	510	591	
Sugar residue mg.	1929	1557	1616	
Sugar used mg.	572	943	884	
Econ. Coeff. Fungus : sugar.	2.08	1.85	1.80	
Econ. Coeff. Sugar : fungus.	0.47	0.54	0.55	

New Plants from Wyoming.—X

By Aven Nelson

Potentilla glomerata

Stems stout, one to several from the thickened woody root, ascending or at length nearly erect, simple, 4–8 dm. high, softly and sparingly hirsute: leaves simple, the radical long-petioled (1–3), the cauline on petioles gradually shorter upwards, the uppermost sessile or nearly so; stipules from oblong to ovate, entire or incised; leaflets oblong or narrowly obovate, subcuneate at base, 3–8 cm. long, pinnately cleft into long, oblong, mostly obtuse teeth, green but finely pubescent above, a close fine whitish pubescence below with a longer pubescence on the veins: inflorescence congested-glomerulate in a few of the upper axils; hypanthium silky, in fruit 8–10 mm. across; bractlets oblong, subacute, shorter than the sepals; sepals lanceolate; corolla small, the petals yellow, nearly orbicular, not exceeding the sepals.

This is another member of the section Graciles as constituted by Dr. Rydberg in his monograph of the N. A. Potentilleae. Of the species there described it is probably nearest to *Nuttallii* Lehm.* from which its simple stems, subtomentose leaves and the strikingly congested inflorescence distinguish it. It is noticeably large-leaved and the stems are stoutish, the leaves becoming smaller and the stems virgate upward.

The type plants were collected on Bear River at Evanston, July 27, 1897, no. 4115. Collected also on Bear River at Cokeville, June 11, 1898, no. 4646.

Castilleja longispica

Perennial, tufted: stems few to many, 2–3 dm. high, branched, the branches slender, erect, closely approximated (fascicled): pubescence of two kinds—a short-hirsuteness with a fine puberulence: leaves slender, 2–5 cm. long, 3-cleft to the middle or thereabouts into linear lobes, the middle lobe largest: bracts with dilated base, 3-cleft to the middle or beyond, the middle lobe oblong, obtuse,

* In my opinion, it is very closely related to *P. Blaschkeana*. I included it in that species in my Monograph, but am now inclined to believe it to be distinct. It differs from that species in less deeply cut leaves and much less dense tomentum.—P. A. Rydberg.

the lateral linear: spikes dense, slender, half the whole length of the plant, yellowish: calyx lobes equal, linear-lanceolate, acuminate, a little shorter than the ovoid tube: corolla 12–15 mm. long, ⅓ longer than the calyx and slightly exceeding the bracts: lip triply saccate, and conspicuously 3-toothed, the sacs shallow: galea broadish, obtuse or subacute, sometimes with a small tooth near the apex, slightly longer than the teeth of the lip.

This plant has been distributed as *Orthocarpus pallescens* Gray, intermingled possibly with some authentic specimens of that species. Both were collected in the same locality and unfortunately were not discriminated and so were distributed ticketed as below. Though perhaps as nearly related to that species as to any other, yet the proposed species is very distinct. Its fascicled branches with their long slender spikes give it a characteristic habit; its equally lobed (4) calyx and its 3-toothed lip which nearly equals its short and broad galea will aid in distinguishing it. The only collection of it at hand is no. 900, Gros Ventre river, Aug. 15, 1894, in part.

Oonopsis argillacea

Tufted, caespitose, the short branches of the multicipital caudex barely reaching the surface of the soil, the crowns more or less covered with the bases of dead leaves: stems numerous, 3–8 cm. long, simple as to the base, terminating in a leafy corymbose inflorescence of few heads, permanently sparsely lanate-pubescent as are also the leaves: leaves entire, narrowly to broadly linear, pungently acute, tapering at the base (those on the crown somewhat petiolate), 4–8 cm. long, many at length overtopping the heads: involucre tomentose, about 1 cm. high, its bracts oblong-ovate, acuminate, not conspicuously green-tipped: rays showy, about 10, the disk flowers twice as many: style appendages lanceolate, as long or longer than the stigmatic portion: pappus moderately abundant, but little shorter than the corolla tube, slightly fulvous: akene softly pubescent, oblong, 3–4 mm. long.

Allied to *O. multicaulis* (Nutt.) Greene, but distinguished by its less ligneous base, much longer leaves which overtop the stems, more numerous heads and rays, longer and more abundant pappus and different style appendages. This occurs on naked clay slopes and flats, a habitat quite in contrast with that of *O. multicaulis*.

Secured by Mr. E. Nelson in Bate's Hole, Carbon Co., July 13, 1898, no. 4867; also on Wallace Creek, near Garfield Peak, July 30, 1898, no. 5009.

Petradoria pumila petiolaris

Tufted like the species, 10–20 cm. high: the branches of the caudex crowded, slender and more numerous, the crowns clothed with dead leaf bases: basal leaves numerous, narrowly linear, on slender (nearly filiform), petioles which are ⅓–½ as long as the blade; stem leaves also linear and petioled: inflorescence similar to that of the species, but less flat-topped and fewer flowered, scarcely surpassing the relatively long leaves.

This plant was secured in 1897, July 17, no. 3581, in the southern portion of Sweetwater County. It occurred in some abundance on stony hillsides in situations similar to that frequented by the species. The species *Petradoria pumila* (Nutt.) Greene was obtained in the same range during that season. The narrow leaves and their much greater relative length gives the variety a very different aspect, but I think the difference can hardly be considered specific.

Tetradymia multicaulis *

Wholly unarmed; the shrubby base tufted, much branched, spreading-assurgent, hardly emergent from the soil: the herbaceous annual stems numerous, somewhat fascicled, simple, erect, 8–15 cm. long, permanently canescent with a dense, appressed tomentum: leaves numerous but not fascicled, narrowly oblong with tapering ends, acute at apex, nearly sessile, like the stems permanently canescent, 15–25 mm. long, midrib usually evident, the pair of lateral nerves obscure: flowers in very compact, terminal clusters of 10–20 heads with bract-like leaves intermingled; heads 12–14 mm. high, four-bracted and four-flowered: pappus copious: akenes villous.

In color of stems and foliage and in floral characters it closely resembles *T. canescens* DC. and *T. inermis* Nutt. but in its caespitose habit it is strikingly different. The numerous erect herbaceous stems are about all that appears above the surface of the soil. It should be noted, too, that these stems are unbranched, in striking contrast with the before mentioned members of this group. The leaves are broader and the venation more conspicuous.

Collected on the Laramie Plains, not far from Laramie, June 24, 1897, by Mr. Elias Nelson. Type specimen in the herb. Univ. of Wyoming, no. 3442.

* Since the description of this species was written more than a year has elapsed and the plant has been carefully observed in the field and again collected as no. 5062. The characters as given are fully confirmed by these later observations and collections.

Senecio Laramiensis

Tufted, perennial: the branches of the caudex with one to several, leafy crowns, permanently white-tomentose, somewhat floccose in age, 1–3 dm. high: stems few to several, slender, ascending, the sparse leaves rather uniform, becoming bract-like in the inflorescence only: basal leaves crowded, linear, rarely narrowly oblanceolate, entire, 4.8 cm. long; stem-leaves similar: inflorescence a corymbose cyme, of few to several heads: heads 10–12 mm. high; calyculate bracts few, small and inconspicuous or none: rays few (10, more or less): akenes oblong, glabrous, inconspicuously striate.

Senecio canus Hook. as represented in herbaria includes several forms that when better understood will probably be considered distinct. The species now proposed is one of the most divergent of these. In fact, it is so different in habit and general appearance that at first one is not inclined to associate it with *S. canus*, but rather with *S. werneraefolius* Gray. Critical examination shows, however, that it is much more nearly related to the former, from which its smaller size and narrow entire leaves are the obvious, superficial characters separating it. It is abundant in the vicinity of Laramie, on the naked, red clay hills. Distributions have been made to many herbaria as *S. werneraefolius* under nos. 224 and 1379. I have seen no specimens of this except the numbers cited and other collections from the same localities.

Senecio Nelsonii Rydb.*

Many-stemmed from a densely tufted caudex whose numerous branches are reduced to short leafy crowns, green and nearly glabrous, the thin tomentum unequally distributed and most of it early deciduous: leaves very numerous, crowded on the crowns and several on the stems, oblong, lanceolate, or oblanceolate in outline, from pinnately toothed to deeply lobed or sometimes divided nearly to the midrib, the segments obtuse or acute, often incisely toothed; stem-leaves slightly reduced upward: stems 2–4 dm. high, simple, terminating in a crowded, corymbose cyme, the upper pedicels subumbellate: heads 7–10 mm. high, calyculate bracts small, only 1 or 2; rays few (6–12), rather large: akenes brown, glabrous, distinctly striate, 2–3 mm. long.

* Professor Nelson had given another name in his manuscript, but that name is a homonym. In his absence on a botanical expedition, I take pleasure in dedicating this species to the discoverer and describer.—P. A. R.

When this was first secured it was confused with *Senecio Fendleri* Gray under which name I have distributed specimens no. 1297, Centennial Hills, June 9, 1895. *S. Fendleri* is, however, a very different plant as I found on examining at the Missouri Botanical Garden, Fendler's nos. 478 and 480, preserved in the Engelmann Herbarium. These are large plants with the appearance of having grown as single, simple, stout, erect individuals, with an open, corymbosely branched inflorescence. Besides, *S. Fendleri* is lanate on stems and involucre.

S. Nelsonii is abundant in the foothills in southern Wyoming, occupying mostly steep naked stony or sandy slopes. Besides the number given, it has been collected also at Green Top, June 28, 1897, no. 3217.

Senecio Nelsonii Uintahensis

Habit and habitat of the species: basal leaves with long slender petioles, all deeply divided, the lobes irregularly and incisely dentate; stem-leaves fewer, similar to the basal but with petioles shorter, sessile above.

This variety is possibly largely a geographical one. The species occurs on stony, sandy slopes in the eastern part of the state while the variety has been secured only in the western. No. 4511, Evanston, June 4, 1898.

Tanacetum simplex

Caudex of few short crowded branches, covered with dead leaf bases, the crowns scarcely above the surface of the ground: leaves crowded on the crowns, closely and finely appressed-silvery-canescent, erect, mostly simple and linear, a few bifid or trifid at apex, only 2–3 cm. long: stems few, rising singly from the crowns (many of the crowns leaf-bearing only), slender, 6–12 cm. high, bearing 2–5 small linear leaves and a single head: head 6–8 mm. high, many-flowered: involucral bracts oval to obovate, in two rows, with slightly thickened greenish midrib and scarious margins: corolla tubes thin and somewhat transparent: the female flowers in one series: akenes oblong, or slightly enlarged upward, obtuse: pappus none: receptacle conical.

Probably closest to *Tanacetum canum* Eaton. Collected near Laramie on a stony slope in the foothills, no. 4325, May 30, 1898. Certainly rare and far from abundant even in the type locality.

Artemisia Natronensis.

A. Ludoviciana integrifolia Aven Nelson, First Rep. Fl. Wyo. 138. 1896.

Stems herbaceous, from a woody persistent crown, suberect, simple, virgate, silvery white-tomentose as are also the leaves, floriferous for nearly half their length, 3–6 dm. high: leaves broadly linear to lanceolate, nearly equally tomentose on both sides, in age the margins revolute, the midrib becoming conspicuous below and the tomentum looser: panicle narrow, its raceme-like clusters in the axils of the leaves which become gradually smaller and bract-like upward or wholly wanting on the summit: heads rather large, campanulate, about 5 mm. high, in small axillary racemes (often only 1–3 heads in each cluster), erect or nearly so even at maturity, about 20-flowered; the bracts ovate to oval: corolla resinous-dotted on the tube only or but sparsely so on the throat and lobes.

A. Ludoviciana as represented in the herbaria is, as every one knows, a composite. Nuttall's description excludes several forms that are often included but are undoubtedly distinct. The species now proposed is one of the forms that I think is clearly separable by valid characters. Possibly it may be *A. integrifolia* Pursh but that name is much antedated. That it is *A. Purshiana* Bess. or *A. Hookeriana* Bess. seems, from the descriptions, improbable. From *A. Ludoviciana* its entire leaves, narrow, virgate panicles, large erect heads and broad involucral bracts distinguish it. The numerous small, crowded heads of the inflorescence of *A. Ludoviciana* are on more or less recurved pedicels and the florets are smaller and resin-dotted throughout.

Type no. is 568, Willow Creek, July 20, 1894, distributed as a variety of *A. Ludoviciana* as given above. Excellent specimens have been collected by Mr. Elias Nelson, Wallace Creek, July 30, 1898, no. 5002—from Natrona county, whence the name.

Malacothrix runcinata

Annual or possibly biennial, leafy on the crown and sparingly so on the stems, mostly glabrous and somewhat glaucous, rarely with small patches of woolly pubescence: stems one to several from the crown of the slender tap-root, erect or, when several, decumbent at base, 5–15 cm. long: leaves rather small, 2–4 cm. long, oblanceolate to linear in outline, from dentate to runcinate: heads one to several on each stem, 8–12 mm. high: involucre

broadly campanulate, its bracts in about three series, some of them dark or purplish-tipped, scarious-margined, linear-lanceolate, subacute, the innermost slightly acuminate: pappus of 12–18 subequal bristles all deciduous together in a ring, 2–3 times as long as the akene: receptacle apparently naked: akenes linear-columnar, about 3 mm. long, the 15 striae subequal, minutely denticulate around the summit.

Probably most nearly allied to *M. sonchoides* T. & G. but the two plants when seen side by side present a very different appearance. The dentate rachis and lobes of the leaves, the dentate outer involucral bracts, the unequally striate akenes and double pappus of *M. sonchoides* are marks easily distinguishing it from *M. runcinata.*

It occurs on dry, sandy slopes, mostly in the protection of the undershrub. Green River, June 15, 1898, no. 4727; Fort Steele, June 18, 1898, no. 4819.

Lactuca sylvatica

Perennial from rootstocks: stem slender, leafy, the internodes gradually shorter upward, glabrous: leaves entire, oblong-lanceolate, the lower tapering into a margined petiole, the upper sessile, thin and wholly glabrous, the largest 10–14 cm. long and 2–3 cm. wide, gradually smaller upward (the uppermost scarcely more than bracts): panicle rather close, of 10–20 heads, its branches more or less short-bracteate: heads 2 cm. high, about 15-flowered: the involucral bracts in about 4 series; the outer short, ovate; the inner linear-lanceolate: flowers blue or lilac: akenes 5 mm. long, lanceolate-oblong, distinctly margined and conspicuously beaked, 4-nerved on each side: the beak nearly half as long as the body of the akene.

Probably to be associated with *Lactuca pulchella* but differing in its entire leaves and margined akenes. The larger akene, longer beak and its broadly expanded summit are also at variance with that.

Collected at Elk Mountain on Medicine Bow River in the copses on the bank, August 1897, no. 4257.

Crepis riparia

Tap-root semi-fleshy, comparatively small, mostly less than 1 dm. long: stems one or more, 2–4 dm. high, subscapose (linear, bract-like leaves at the base of the lower branches of the panicle

and sometimes a single leaf near the base of the stem), minutely and sparsely pubescent below, the pubescence more conspicuous upward and becoming clammy or (on the pedicels) glandular: radical leaves few, rather large, oblong to elliptic, obtuse to subacute, entire or coarsely and irregularly dentate and at base more or less runcinate, 10–18 cm. long, on petioles of about half the length, glabrous except on the petioles and midrib: inflorescence corymbose-paniculate, the few to several heads of the branches of the panicle being crowded at their summits: heads 15–20 mm. high, many-flowered: involucre dark, glandular-pubescent: bracts linear, in two rows; the outer few and short; inner more numerous (12–16): akenes tapering gradually from base to summit, about 6 mm. long, rather uniformly 10-striate, light brown: pappus soft and white, shorter than the akene.

A few specimens were distributed as no. 1857 (Centennial Valley, Aug. 25, 1895) under the name *Hieracium Fendleri* Schultz Bip. From this it is clearly distinct, however.* The only specimens duplicating the number cited above that I have seen were collected by T. A. Williams and also distributed as *H. Fendleri.*

* Its nearest relative is *C. runcinata* T. & G., but is easily distinguished from that species by the larger, more distinctly turbinate head and larger leaves which are much more deeply runcinate at the base.—P. A. R.

The Advantages of 1737 as a Starting Point of Botanical Nomenclature*

By Dr. Otto Kuntze

At request of the editor of this journal [*Gaertnerisches Zentralblatt*], I give the following newly proved list of generic names, that do not need to be changed if the starting-point of 1735 is abandoned. The numbers before the names are the approximate number of species:

15 *Aesculus* (*Pavia* 1735).
30 *Ageratum* (*Carelia* 1736).
45 *Ajuga* (*Bulga* 1735).
58 *Arctotis* (*Anemonospermos* 1736).
1400 *Astragalus* (*Tragacantha* 1737) incl.:
150 *Spiesia* = *Oxytropsis* according to Briquet and Burnat.
23 *Bulbine* (*Phalangium* 1736).
21 *Carica* (*Papaya* 1735).
8 *Carpesium* (*Conyzodes* 1736).
1 *Cassandra* (*Hydragonum* 1736).
132 *Clitoria* (*Ternatea* 1735).
3 *Coix* (*Sphaerium* 1735).
1 *Convallaria* § L. (*Majanthemum* 1736). [§ is the sign for group (section, subgenus or discretionary genus); § L. 1737 means a group of Linnaeus.]
230 *Cordia* (*Lithocardium* 1735).
6 *Corrigiola* (non 1736.)
170 *Crepis* (*Hieraciodes* 1736), if separated.
600 *Croton* (*Oxydectes* 1735).
1 *Cuminum* (non 1735).
180 *Cynanchum* (*Vincetoxicum* 1736) sensu latiore.
1 *Dryas* (*Dryadaca* 1735).
72 *Echinops* (*Sphaerocephalus* 1735).
12 *Elatine* (*Potamopithys* 1735).

* Translated by the author from the *Gaertnerische Zentralblatt*, Berlin, 1899, No. 2. The article contains a new motive for 1737 and at the last a new international proposition not yet known to American botanists.

400 *Erica* Ludw. 1737 (*Ericodes* Möhr. 1736).—*Erica* L. 1737 is partly *Calluna* Salisb. 1802 = *Ericodes* Ludw. 1737 (non Moehr.), z. T. *Erica* Ludw.—Linnaeus' indication "*Semina numerosa*" is only fit for *Erica* Ludw., because *Ericodes vulgare* O. K. (*Calluna vulg.*) has at most 8 seeds.

34 *Erythrina* (*Corallodendron* 1735).

8 *Feuilléea* (non 1735).

5 *Galanthus* (*Chianthemum* 1736).

2 *Galeopsis* (*Ladanum* 1735).

180 *Geranium* § L. 1737; 1753 ex parte max. (*Geraniospermum* Sieg. 1736 = *Pelargonium!* Burm. 1738); eventually incl.

— *Gruinalis* § L. 1737, Ludw. 1737, Haller 1745 (*Geranium* Sieg., L'Hér.).—Linnaeus distinguished 1737 (in Genera Plant.: 204) under *Geranium* in an observation: *Geranium* "Riv.," corolla irregulari. *Gruinalis* "Riv.," corolla aequali et filamentis vix manifeste coalitis. Haller in Flora Jenensis 1745 had under *Gruinalis* only species which we call now *Geranium*. Nearly all species of *Pelargonium* are already named under *Geranium*, and *Geranium* is still a popular name of several nations instead of *Pelargonium*. But it would not be necessary to name the species under *Gruinalis*, because both genera are better united again, as all indicated differences are not decisive, varying from species to species.

90 *Gomphrena* (*Xeraca* 1735).

30 *Helenium* (non 1735).

1 *Illecebrum* (non 1736).

400 *Inga* § L. 1737 (*Feuilléea* 1735) sensu latiore.

90 *Inula* (*Helenium* 1735).

1 *Lagoecia* (*Cuminium* 1735).

100 *Lepidium* (*Nasturtium* 1735).

12 *Linnaea* (*Obolaria* 1736).

1 *Lunularia* (*Marsilia* 1735).

23 *Melilotus* (*Sertula* 1735).

4 *Melia* (*Azedarach* 1735).
13 *Michelia* (non 1735).
156 *Nepeta* (incl. *Glechoma* 1735).
1 *Obolaria* (non 1736).
8 *Ornithopus* (*Ornithopodium* 1735).
2 *Patagonula* (*Patagonica* 1735).
220 *Oxalis* (*Acetosella* 1736).
27 *Phlox* (*Armeria* 1735).
540 *Phyllanthus* (*Diasperus* 1735) sensu latiore.
10 *Pistacia* (*Lentiscus* 1735).
110 *Psidium* (*Guajava* 1736), if separated.
105 *Psoralea* (*Lotodes* 1736).
120 *Rhus* (*Toxicodendron* 1735).
15 *Sesamum* (*Volkameria* 1735).
54 *Sisyrinchium* (*Bermudiana* 1735).
80 *Stapelia* (*Stissera* 1735).
115 *Thesium* (*Linosyris* 1736).
48 *Tropaeolum* (*Trophaeum* 1735).
75 *Trigonella* (*Telis* 1735).
44 *Trichosanthes* (*Anguina* 1735).
1 *Zea* (*Thalysia* 1735).

6285 species in *58* genera with long-used names remain thus valid. But 329 species in 9 genera, valid from the former starting point, receive new names; therefore *5956* species in *49* genera are spared, that is, are less to be changed, in their names, if we begin with 1737 instead of 1735. But this is the only profitable deviation from the Paris Code.

Moreover, the starting of 1737 affords the great advantage, that Linnaeus' Genera Plantarum 1737 contains besides the scientific diagnoses of the genera (which are in 1753 without diagnoses!) also definitions for named subgenera or discretionary genera; by which means an easy separation is possible into later distinguished genera. Linnaeus wrote, for instance: *Hyacinthus*, genus hocce naturale in plura non naturalia distribuerunt: (α) *Hyacinthus* quum tubus corollae sit tubulatus oblongus: (β) *Muscari* quum tubus corollae sit fere globosus. In the same manner is distinguished *Convallaria* (α) from (β) *Polygonatum*, (γ) *Unifolium*. The last is now mostly valid for *Majanthemum*. In the year 1737 *Myagrum*

§ L.: *Rapistrum* § L.—is clear although united under *Myagrum*; in the year 1753, when these sections (§ = subgenera = genera discretionaria) are omitted, we must decide *ex parte majore*, else the matter loses its clearness and becomes confused. The case is the same in *Calendula* and § *Dimorphotheca*, *Helianthemum* and *Cistus*, etc. The following names are thus obtained from the §§ of 1737 for later renewed genera: *Acacia*, *Alhagi*, *Arnica****, *Arisarum*, *Bernhardia*, *Bulbocodium**, *Cakile*, *Camara*, *Cannabina**, *Capnodes*, *Capnorchis**, *Castanea***, *Ceratodes*, *Cereus***, *Colocynthis**, *Damasonium*, *Dimorphotheca*, *Dracunculus*, *Echinophora*, *Elephas*, *Foeniculum***, *Helianthemum*, *Helleborodes**, *Hypocistis*, *Jonthlaspi*, *Lantana* § (= *Oftia*), *Lasianthus****, *Leuconymphaea** (= *Nymphaea auct. recent.!*), *Nymphaea* (= *Nuphar!*), *Liliastrum*, *Limonium*, *Majorana*, *Malvaviscus*, *Meibomia**, *Melilotus*, *Melocactus*, *Muscari*, *Nelumbo*, *Myagrum*, *Onobrychis*, *Opuntia*, *Paliurus*, *Polygonatum*, *Raphanistrum*, *Rapistrum*, *Rhagadiolus*, *Securidaca* (*Securigera* DC.), *Statice*, *Symphoricarpus*, *Thymbra**, *Triosteospermum*, *Trollius**, *Tulipifera*, *Unifolium*, *Zacintha***.—(One * means that Linnaeus gave such an * to these names in the index of his Genera Plantarum; ** means that Linnaeus had that name in 1735 for a genus; *** indicates both.)

From these discretionary genera considered by Linnaeus and other authors at one time as genera, at another time as sections, a systematic decision is easy; only two dubious cases occur: the first rare case is that the same group (*a*) received two names, such as *Sida* and *Malvinda*; then the genus name, which received first a species name, is valid. The other case is that three to four names occur for the same now united group; then the name under which they were first correctly united, is to be valid. For instance, *Lonicera* 1737 consists of four genera and is thus confused; Haller after exclusion of the genera not belonging thereto, first united *Caprifolium*, *Periclymenum*, *Chamaecerasus*, *Xylosteum* under *Caprifolium*. *Lobelia* Pl. is correctly defined as a § and is therefore to be excluded; the rest was named then at first *Rapuntium*, under which name most of the species are already named in the monograph of Presl. Some genera would have to receive new names, if their name were not secured from the § of 1737, *e. g.*, *Helianthemum*. The name *Cactus*, after exclusion of the §§ of 1737, remains good for the remaining part.

In contrast to these great advantages and savings of the *1737*-starting-point, there are—see my Revisio Generum III[II], chapter 27 and 28—to be changed with the *1753*-starting-point the names of *7100* species and *129* genera, whereof only 29 genera with 152 species are named up to the present time. Furthermore *46* genera thereof with *3621* species would have still to receive new and unusual names instead of those introduced from the earlier starting-point. But even with this the number of these changes is not finished, because the starting-point of 1753 for genera has not yet been completely worked out. This 1753-starting-point is thus not only horribly *noxious* but also *unscientific*, as it misses the genera-diagnoses and nearly all the named genera-sections. *Only the 1737-starting-point is practicable, scientific, and economical for genera.* Perhaps a general convention may be agreed upon to the effect that the 1737-starting-point be valid for genera, 1753 for species *with future exclusion of all intermediate works*, that is of all publications between Linnaeaus' Genera Plantarum 1737 and Species Plantarum 1753.

New Fungi from Mississippi

By S. M. Tracy and F. S. Earle

Descriptions of other fungi from Mississippi have been published by the authors in this Bulletin, **22**: 174–179, and **23**: 205–211, and lists of all parasitic species known from the state in Bulletins 34 and 38 of the Mississippi Agricultural Experiment Station. The following additions are from the Gulf Coast and adjacent islands, a region that has already afforded a large number of new or local species, both among fungi and the higher plants. Types of the following are in the herbaria of the authors, and duplicates from the same collections have been placed in the herbaria of Columbia and Harvard Universities, Rutgers College, Missouri Botanical Garden and other institutions.

Aecidium Stillingiae

Hypophyllous or rarely amphigenous: spots definite, bright yellow, 1 cm. or more in diameter: pseudoperidia densely crowded, cylindrical, elongated, .5–.75 mm., irregularly lacerate and recurved, cells quite uniformly pentagonal, conspicuously roughened by ridge-like folds, 25–30 μ; aecidiospores light yellow, subspherical, epispore thick, slightly roughened, 22–29 μ.

On leaves of *Stillingia ligustrina*, Wisdom, Miss., June 14, 1897, S. M. Tracy, no. 3413. Also previously collected at Ocean Springs, Miss.

Ustilago caricicola

Involving occasional spikes, only slighty distorting the inflorescence: spore masses hard, brown, 2–5 mm. in diameter, externally fibrous and almost wool-like; spores mostly ovoid, minutely echinulate, slightly fuscous, about 6 × 4 μ.

On *Carex folliculata*, Augusta, Miss., June, 1897, S. M. Tracy, no. 3343; Beauvoir, Miss., May, 1898.

Ustilago Psilocaryae

Involving but not destroying the ovaries, transforming the seeds into black powdery masses: spores lenticular, dark brown, opaque, epispore thick, reticulated, 10–14 μ in diameter, 6–8 μ thick.

On *Psilocarya rynchosporioides*, Horn Island, Miss., Oct., 1894, and Oct., 1898, S. M. Tracy, no. 5226.

SOROSPORIUM RYNCHOSPORAE P. Henn.

On *Rynchospora semiplumosa*, Biloxi, Miss., June, 1898, S. M. Tracy, no. 5225.

This South American smut is new to the United States.

Cerebella Anthaenantiae

Destroying the ovaries: stomatic mass globose, 3–5 mm. in diameter, at first reddish-orange, becoming velvety black with the maturity of the dark colored spores: glomerules subglobose, composed of several, sometimes 10 or 12, connate spores that are quite variable in size, the larger 20–24 μ; separate spores ovoid or angular from pressure, fuscous, average size 10–12 μ × 8–10 μ.

On *Anthaenantia rufa*, Ocean Springs, Miss., fall of 1890. Biloxi, Miss., Oct., 1894 and 1898, S. M. Tracy, no. 5219.

This form was mentioned in Bull. Miss. Ag. Exp. Sta. **34**: 94 under *C. Paspali* and was then tentatively referred to that species.

Cerebella Panici

Infesting the ovaries: stomatic mass oval, 1.5–3 mm. often covering the glumes, nearly black throughout: glomerules depressed-spherical, composed of 3–5 spores, dark-olivaceous, smooth or minutely roughened, 10–12 μ × 8–10 μ, remains of pedicel usually distinct; spores ovoid, angular on inner sides, about 8 × 6 μ.

On *Panicum virgatum*, Ocean Springs, Miss., 1891; Biloxi, Miss., Oct., 1898, S. M. Tracy, no. 5217.

Mentioned in Bull. Miss. Ag. Exp. Sta. **34**: 94 and there referred to *C. Paspali.*

Cerebella Sorghi

Infesting the ovaries: stomatic mass globose, 5–6 mm. in diameter, enveloping the glumes, dark or black throughout: glomerules subglobose, usually composed of three spores, smooth or slightly roughened, brown, 8–10 μ in diameter; spores ovoid, 6–8 × 5–6 μ.

On *Sorghum nutans*, Manuel, Jackson Co., Miss., Sept., 1898.

The form on *Chrysopogon avenaceus* from Tuskegee, Ala., that was referred to *C. Andropogonis* in Bull. Ala. Ag. Exp. Sta. **80**: 207, probably belongs here.

Diplodina quercuum (Cke.) Tracy & Earle

Hypophyllous, without spotting or discoloring the leaves: perithecia subsuperficial, solitary or gregarious, subconic, about 150 ×

100 μ, black: sporules elliptical, hyaline, uniseptate, not constricted, guttulate, 16–18 μ × 4–5 μ.

On living leaves of *Quercus Virginiana*, Ocean Springs, Miss., Feb., 1898, Tracy & Earle, no. 5253.

This seems to be *Sphaerellopsis quercuum* Cke. Grev. **12**: 23 and *Ascochyta quercuum* (Cke.) Sacc. Syll. Fung. **3**: 393, as nearly as can be determined from the brief and unsatisfactory description.

Coniosporium palmicola

Epiphyllous: acervuli abundant, scattered, subrotund, .5–.75 mm. in diameter, permanently covered by the epidermis which finally splits along one or both sides: sporules globose, opaque, minutely roughened, 11–13 μ.

On languishing leaves of *Sabal serrulata*, Biloxi, Miss., 1898, S. M. Tracy, no. 5243.

Cercospora Decumariae

Epiphyllous, occupying deadened areas at the apical end of the leaf, diffused: hyphae fasciculate in large clusters from a tuberculate base, short, simple, continuous, fuscous, 15–20 × 5–6 μ: conidia narrowly obclavate, much attenuated below, slightly fuscous, the enlarged upper part 5–7-septate, the attenuate lower portion continuous, 70–80 μ × 4–5 μ.

On languishing leaves of *Decumaria barbara*, Ocean Springs, Miss., Nov., 1897, S. M. Tracy, no. 5206.

Cercospora Morongiae

Caulicolous: spots definite, dark colored, oval, 3–5 mm. long: hyphae in dense clusters, simple or rarely branched, frequently septate, somewhat torulose, fuscous, 75–100 μ × 4–5 μ: conidia obclavate, fuscous, 3–5-septate, 50–60 μ × 3–4 μ.

On stems of *Morongia uncinata*, Ocean Springs, Miss., Apr., 1898, S. M. Tracy, no. 5205.

Cercospora Oxydendri

Hypophyllous on brown and deadened spots sometimes reaching 1 cm.: hyphae in small clusters, simple or branched, nodulose, several-septate, slightly fuscous, 20–25 μ × 5–6 μ: conidia slender, curved, nearly hyaline, 4–7-septate, 50–60 μ × 3 μ.

On languishing leaves of *Oxydendron arboreum*, Biloxi, Miss., Oct., 1898, S. M. Tracy, no. 4086.

Studies in Sisyrinchium—V: Two new eastern Species

By Eugene P. Bicknell

Up to the present time four species of *Sisyrinchium* have been recognized in the flora of the eastern coastwise states from New Jersey northward. These are *S. angustifolium* Miller, the commonest species of New York and New England and the only one ranging far northward and eastward through Maine to the provinces; *S. graminoides*, extending from east Massachusetts far southward and westward; *S. Atlanticum*, abundant along the coast from Massachusetts southward and occasionally found inland, as at Stratton, Vermont (A. J. Grout) and Concord, New Hampshire (W. W. Eggleston), and *S. mucronatum* Michx., common in the Alleghany region of east Pennsylvania and extending to central New York but as yet not reported east of the Delaware River.

To these four species two others must now be added, one a coastwise plant of New York and New Jersey, the other occuring from southern New Jersey southward. These new species are here described.

Sisyrinchium arenicola

Closely caespitose in stiff erect tufts 20–40 cm. tall from short woody rootstocks, the tufts coarsely brown-fibrous at base, the fibrous roots numerous, long and slender, becoming nearly black: stems and leaves rather bright green, sometimes glaucescent, readily discoloring to brown or black in drying, the spathes and often the stems and leaves purplish-tinged: leaves usually over half the height of the stem, stiff and erect, often slightly curved, .5–3 mm. wide, cuspidate-attenuate, strongly close-striate, minutely cellular-puncticulate between the nerves, the edges denticulate-serrulate to smooth: stem erect but often forming a shallow double curve, sometimes spirally twisted, 1–3 mm. wide, the distinct wings firm, striate, denticulate-serrulate or smooth; bracteal leaf conspicuous, erect, continuing the line of the stem, often slightly incurved, attenuate-acute, usually subequal with the peduncles, the rather broad compressed base strongly striate and oppositely bicarinate; peduncles 2–4, suberect or somewhat outcurved, in their early development appearing lateral from the stem, approximate or, when only two, the outer one often divergent, somewhat unequal, very short or elongated, 3–12 cm. long, stiff, wing-mar-

gined and serrulate, mostly 1 mm. or more wide (.5–2 mm.): spathes erect, the mostly cuspidate-acuminate bracts striate with delicate raised nerves, slightly unequal or the outer one slenderly prolonged for as much as 2 cm. when, as not infrequently occurs, the stem is simple; interior scales brownish-tinged, becoming over ¾ the length of the inner bract: flowers deep violet-blue, often numerous, 3–12, on nearly erect, slightly exserted pedicels 15–22 mm. long, which become somewhat spreading above in fruit; perianth 8–10 mm. long; stamineal column 4–5 mm. high, anthers small, bright orange-yellow; capsules dark and thick-walled, subglobose to obovoid, 3–5 mm. high: seeds black, globose, 1–1.5 mm. in diameter, distinctly pitted and with a rather prominent umbilicus.

In sand or sandy soil near the coast, Long Island to New Jersey, flowering from June till August, the fruit sometimes persisting till October.

New Jersey: Point Pleasant, Ocean Co., July 17, 1882, E. H. Day: Monmouth Co., Oct. 2, 1886, N. L. Britton.

New York: Staten Island, Todt Hill, June 12, 1887, and Tottenville, Aug. 3, 1890, N. L. Britton; Long Island, Southampton, June, 1898, W. N. Clute; Hempstead, June 30, 1899, Miss Fanny A. Mulford; Sag Harbor, July 20, 1899, still in flower, N. L. Britton; Amagansett, Aug. 7, 1899, Miss E. Babcock.

The specimens cited are contained in the herbaria of Columbia University and the New York Botanical Garden and in my private collection.

An interesting and unexpected addition to our eastern coast flora, of very restricted range, so far as yet appears, but in all probability extending further south than New Jersey and eastward to the New England coast.*

The species is a perfectly distinct one and though appearing intervenient with *S. graminoides* and *S. Atlanticum* is in closer relationship with a group of more southern species, including *S. xerophyllum* Greene and *S. rufipes*, characterized by a dense fibrous coating about the base of the tufts. In the possession of this character *S. arenicola* differs notably from all other species of the northern states except *S. Farwellii*, a very different species in other respects.

On herbarium sheets specimens sometimes show fully as much

* Mr. Bicknell writes, under the date of September 14, that he finds *S. arenicola* the common species on Nantucket Island.—Ed.

discoloration as *S. graminoides* and might be easily passed over for that species, but a moment's attention will discover that the plant is more caespitose and stiffer in habit than *S. graminoides* with narrower and more attenuate leaves which are thicker and more strongly striate; other evident differences are shorter, frequently clustered peduncles, stiffer and more striate bracts, more numerous flowers and smaller capsules on less exserted and spreading pedicels.

As compared with *S. Atlanticum*, *S. arenicola* is stouter and stiffer, never developing a flexuous prolongation of the stem from a lower node, and having much less membranous bracts which are decidedly more striate-nerved and acuminate, also the capsules are relatively more subglobose and the seeds larger. Perhaps the most evident feature of contrast between the two plants is in color, the rather deep green of *S. arenicola* producing a very different general effect from the very pale glaucous-green of *S. Atlanticum*.

It should also be noted that the flowering period of *S. arenicola* is considerably later than that of *S. Atlanticum* or *S. graminoides*.

Sisyrinchium intermedium

Dull green, sometimes not even glaucescent, turning dark in drying, the spathes purple or occasionally green: tufts not fibrous at base, 15–35 cm. high, the stems often numerous, the clustered roots numerous and slender: leaves erect, about half the height of the tufts, 1.5–2.5 mm. wide, attenuate and cuspidate-acute, thin and grass-like, the delicate nerves usually with a fainter alternating series, the tissue between minutely cellular-puncticulate, the edges minutely serrulate or even subciliolate-serrulate to smooth; young leaves sometimes roughened on the sides with minute points: stems very straight, frail, mostly 1.5 mm. wide (1–2.5 mm.), the thin wings with closely fine-serrulate edges and nerved like the leaves, usually much broader than the very narrow raised line of the proper stem; stems in some tufts all or nearly all simple, in others mostly forked at the top into two or even three pedunculate spathes subtended by a rather longer erect bracted leaf; peduncles 3–7 cm. long, often roughened on the sides with minute points, the outer one somewhat divergently outcurved, usually slender but distinctly winged, the wings serrulate, gradually widened into the base of the spathe: spathes narrow, sometimes not wider than the stem, erect, flattened and rather sharply two-edged, the sides narrowed to the base and margined

below by the ascending wings of the stem; bracts thin, glabrous, delicately nerved, the outer one on simple stems prolonged beyond the inner 8–40 mm. and sometimes three times its length, in pedunculate spathes often but little prolonged, 2–6 cm. long, obscurely or very narrowly hyaline-margined, the edges not united below; inner bract narrow, 15–20 mm. long, narrowly hyaline-margined, mostly attenuate and cuspidate-acute, rarely scarious-obtuse and mucronulate; interior scales acuminate, brownish-tinged, about ⅔ the length of the inner bract: flowers 5–6, pale blue; perianth 8–14 mm. long; stamineal-column 4–5 mm. high: capsules on slenderly exserted and flexuously spreading pedicels 17–25 mm. in length, brown, broadly subglobose, or obovoid, 4 mm. high.

Southern New Jersey to North Carolina, flowering in May and early June.

New Jersey: Gloucester Co., June 1, 1892, B. Heritage, Herb. Phil. Bot. Club.

Pennsylvania: Philadelphia, A. B. Monoy, Herb. Mo. Bot. Gard.

District of Columbia: W. M. Canby, U. S. Nat. Herb.

North Carolina: Buncombe Co., Thos. Hogg, May, 1886, Herb. Columbia Univ.; G. McCarthy, May, 1888, U. S. Nat. Herb.; May 8, 1897, Biltmore Herb.; Wake Co., May, 1896, W. W. Ashe, Herb. W. W. A.; Henderson Co., Mrs. Schoolbred, 1857, Herb. N. Y. Bot. Gard.; also two sheets without record in Herb. Mo. Bot. Gard., one "ex herb. Bernhardi."

A perplexing plant appearing about intermediate between *S. graminoides* and *S. mucronatum*, yet not to be correlated with either one, although in its most divergent forms, showing a near approach to both. The more branched forms, which are nearest to *S. graminoides* differ in narrower and more attenuate leaves and purple spathes, and usually also develop many simple stems bearing spathes with much prolonged outer bracts; the branches when present are mostly shorter and more slender than in *S. graminoides* and, like the younger leaves, may be roughened on the sides; the margins of the stem and leaves are also usually more definitely serrulate than in *S. graminoides*.

The opposite form in which the stems may be all simple closely simulates *S. mucronatum* but dries dark and has thinner, more broadly winged stem and larger darker capsules on flexuously spreading pedicels as in *S. graminoides*.

A Synopsis of the Proceedings of the Botanical Organizati ns meeting at Columbus, Ohio, August 17–25, 1899

THE BOTANICAL SOCIETY OF AMERICA

The fifth annual meeting was held at Columbus, August 18 and 19, Dr. L. M. Underwood presiding.

In the absence of the Secretary, Prof. G. F. Atkinson, Dr. Arthur Hollick was made Secretary *pro tem.*

The following new members were elected: J. M. Macoun, Geological Survey of Canada; W. J. Beal, Michigan Agricultural College; C. F. Millspaugh, Field Columbian Museum; Marshall A. Howe, Columbia University.

The retiring President, Dr. N. L. Britton, delivered an address entitled: "Report of Progress of the Development of the New York Botanical Garden."

The following papers were presented:

1. Apetaly and Dioeciousness. By C. E. Bessey.

2. The Spore Mother Cells of *Anthoceros.* By Dr. B. M. Davis.

3. Symbiosis and Saprophytism. By Dr. D. T. MacDougal.

4. The effect of Centrifugal Force upon the Cell. By Dr. D. M. Mottier.

5. The American Species of *Arisaema.* By Dr. N. L. Britton.

6. The Uredineae Occurring upon *Phragmites, Spartina* and *Arundinaria* in America. By Prof. J. C. Arthur (read by title).

7. Some notes upon the Distribution of American Erysiphaceae. By Prof. B. D. Halsted (read by title).

8. Gametes and Gametangia of the Phycomycetes. By Dr. B. M. Davis (read by title).

9. Etiolative Reactions. By Dr. T. MacDougal (read by title).

10. The Foundation of Genera among the Ferns. By Prof. L. M. Underwood (read by title).

11. The Classification of Botanical Publications. By Prof. Wm. Trelease.

The following officers were elected for the coming year: President, Dr. B. L. Robinson; Vice-President, Prof. B. D. Halsted; Secretary, Prof. G. F. Atkinson; Treasurer, Dr. Arthur Hollick; Councillors, Prof. D. P. Penhallow and Prof. B. T. Galloway.

TITLES OF PAPERS READ BEFORE THE SECTION OF BOTANY, A.A.A.S., COLUMBUS MEETING

C. R. Barnes, Chicago, Vice-President; W. A. Kellerman, Columbus, Secretary. Address by Vice-President Barnes, subject: "The Progress and Development of Plant Physiology." The following papers were then presented:

1. The Fertilization of *Albugo Bliti.* By F. L. Stevens, Chicago, Ill.

2. The Embryo Sac of *Leucocrinum montanum.* By Francis Ramaley, Boulder, Col.

3. Notes on subterranean Organs. By A. S. Hitchcock, Manhattan, Kans.

4. Some Monstrosities in Spikelets of *Eragrostis* and *Setaria* with their Meaning. By W. J. Beal, Agricultural College, Mich.

5. Studies of Vegetation of the high Nebraska Plains. By Charles Edwin Bessey, Lincoln, Neb.

6. The Tamarack Swamp in Ohio. By A. D. Selby, Wooster, Ohio.

7. The Breeding of Apples for the Northwest Plains. By William Saunders, Experimental Farms, Ottawa, Canada.

8. Field Experiments with 'Nitragin' and other Germ Fertilizers. By Byron D. Halsted, New Brunswick, N. J.

9. The Duration of bacterial Existence under trial Environments. By Henry L. Bolley, Agricultural College, N. D.

10. Suggestions for a more satisfactory Classification of the pleurocarpous Mosses. By A. J. Grout, Brooklyn, N. Y.

11. Notes concerning the Study of Lichen Distribution in the Mississippi Valley. By Bruce Fink, Fayette, Iowa.

12. Botanical Teaching in the secondary Schools. By W. C. Stevens, Lawrence, Kansas.

13. Botanical Teaching in the secondary Schools. By Ida Clendenin, Brooklyn Girls' High School.

14. On the Occurrence of the Black Rot of Cabbage in Europe. By H. A. Harding, Geneva, N. Y.

A Synopsis of the Proceedings of the Botanical Organizati ns meeting at Columbus, Ohio, August 17–25, 1899

THE BOTANICAL SOCIETY OF AMERICA

The fifth annual meeting was held at Columbus, August 18 and 19, Dr. L. M. Underwood presiding.

In the absence of the Secretary, Prof. G. F. Atkinson, Dr. Arthur Hollick was made Secretary *pro tem.*

The following new members were elected: J. M. Macoun, Geological Survey of Canada; W. J. Beal, Michigan Agricultural College; C. F. Millspaugh, Field Columbian Museum; Marshall A. Howe, Columbia University.

The retiring President, Dr. N. L. Britton, delivered an address entitled: "Report of Progress of the Development of the New York Botanical Garden."

The following papers were presented:

1. Apetaly and Dioeciousness. By C. E. Bessey.

2. The Spore Mother Cells of *Anthoceros.* By Dr. B. M. Davis.

3. Symbiosis and Saprophytism. By Dr. D. T. MacDougal.

4. The effect of Centrifugal Force upon the Cell. By Dr. D. M. Mottier.

5. The American Species of *Arisaema.* By Dr. N. L. Britton.

6. The Uredineae Occurring upon *Phragmites, Spartina* and *Arundinaria* in America. By Prof. J. C. Arthur (read by title).

7. Some notes upon the Distribution of American Erysiphaceae. By Prof. B. D. Halsted (read by title).

8. Gametes and Gametangia of the Phycomycetes. By Dr. B. M. Davis (read by title).

9. Etiolative Reactions. By Dr. T. MacDougal (read by title).

10. The Foundation of Genera among the Ferns. By Prof. L. M. Underwood (read by title).

11. The Classification of Botanical Publications. By Prof. Wm. Trelease.

The following officers were elected for the coming year: President, Dr. B. L. Robinson; Vice-President, Prof. B. D. Halsted; Secretary, Prof. G. F. Atkinson; Treasurer, Dr. Arthur Hollick; Councillors, Prof. D. P. Penhallow and Prof. B. T. Galloway.

TITLES OF PAPERS READ BEFORE THE SECTION OF BOTANY, A.A.A.S., COLUMBUS MEETING

C. R. Barnes, Chicago, Vice-President; W. A. Kellerman, Columbus, Secretary. Address by Vice-President Barnes, subject: "The Progress and Development of Plant Physiology." The following papers were then presented:

1. The Fertilization of *Albugo Bliti.* By F. L. Stevens, Chicago, Ill.

2. The Embryo Sac of *Leucocrinum montanum.* By Francis Ramaley, Boulder, Col.

3. Notes on subterranean Organs. By A. S. Hitchcock, Manhattan, Kans.

4. Some Monstrosities in Spikelets of *Eragrostis* and *Setaria* with their Meaning. By W. J. Beal, Agricultural College, Mich.

5. Studies of Vegetation of the high Nebraska Plains. By Charles Edwin Bessey, Lincoln, Neb.

6. The Tamarack Swamp in Ohio. By A. D. Selby, Wooster, Ohio.

7. The Breeding of Apples for the Northwest Plains. By William Saunders, Experimental Farms, Ottawa, Canada.

8. Field Experiments with 'Nitragin' and other Germ Fertilizers. By Byron D. Halsted, New Brunswick, N. J.

9. The Duration of bacterial Existence under trial Environments. By Henry L. Bolley, Agricultural College, N. D.

10. Suggestions for a more satisfactory Classification of the pleurocarpous Mosses. By A. J. Grout, Brooklyn, N. Y.

11. Notes concerning the Study of Lichen Distribution in the Mississippi Valley. By Bruce Fink, Fayette, Iowa.

12. Botanical Teaching in the secondary Schools. By W. C. Stevens, Lawrence, Kansas.

13. Botanical Teaching in the secondary Schools. By Ida Clendenin, Brooklyn Girls' High School.

14. On the Occurrence of the Black Rot of Cabbage in Europe. By H. A. Harding, Geneva, N. Y.

15. One Thousand Miles for a Fern. By Charles E. Bessey, Lincoln, Neb.

16. A Summary of our Knowledge of the Fig, with Illustrations. By Walter T. Swingle, Washington, D. C.

17. The Classification of botanical Publications. By Wm. Trelease, St. Louis, Mo.

18. The Geotropism of the Hypocotyl of Cucurbits. By Edwin Bingham Copeland, Chico, Cal.

19. The Destruction of Chlorophyll by oxidizing Enzymes. By A. F. Woods, Washington, D. C.

20. The Effect of Hydrocyanic Acid Gas upon the Germination of Seeds. By C. O. Townsend, College Park, Md.

21. Some physiological Effects of Hydrocyanic Acid Gas upon Plants. By W. G. Johnson, College Park, Md.

22. Etiolative Reactions of *Sarracenia* and *Oxalis*. By Wm. B. Stewart, Minneapolis, Minn.

23. The Mycorhiza of *Tipularia*. By Julia B. Clifford, Minneapolis, Minn.

24. The Cultures of Uredineae in 1899. By J. C. Arthur, Lafayette, Ind.

25. The Embryology of *Vaillantia hispida*. By Francis E. Lloyd, Teachers College, Columbia University, N. Y. City.

26. Division of the megaspore of *Erythronium*. By J. H. Schaffner, Columbus, Ohio.

27. The Flora of Franklin County, Ohio. By A. D. Selby, Wooster, Ohio.

28. The fungous Infestations of agricultural Soils in the United States. By Erwin F. Smith, Washington, D. C.

29. Are the Trees advancing or retreating upon the Nebraska Plains? By C. E. Bessey, Lincoln, Neb.

30. Useful Trees and Shrubs for the Northwest Plains of Canada. By Wm. Saunders, Ottawa, Canada.

31. The Occurrence of Calcium Oxalate and Lignin during the Differentiation of the Buds of *Prunus Americana*. By H. L. Bolley and L. R. Waldron, Agricultural College, North Dakota.

32. Two Diseases of *Juniperus*. By Hermann von Schrenk, St. Louis, Mo.

33. The Crystals in *Datura Stramonium* L. By Henry Kraemer, Philadelphia, Pa.

For the coming year, Wm. Trelease was elected Vice-President and Chairman of Section G; D. T. MacDougal, Secretary.

BOTANICAL CLUB OF THE A. A. A. S.

Byron D. Halsted, President; F. H. Knowlton, Vice-President; A. D. Selby, Secretary *pro tem.*, in the absence of Stewardson Brown, Secretary.

The following papers were read:

1. A Greasewood Compass Plant. By C. E. Bessey.

2. A Visit to the original Station of the Rydberg Cottonwood. By C. E. Bessey.

3. Report of the Expedition to Porto Rico from the New York Botanical Garden. By N. L. Britton.

4. The Arboretum and Botanical Garden of the Central Experimental Farm at Ottawa, established in 1889. By Wm. Saunders.

5. Tomato Fruit Rot. By F. S. Earle.

6. Two hitherto confused species of *Lycopodium*. By Francis E. Lloyd.

7. Some of the Investigations on Grasses and Forage Plants in charge of the Division of Agrostology, U. S. Dept. of Agriculture. By Thos. A. Williams.

8. The Wilting of *Cleome integrifolia*. By C. E. Bessey.

9. The Powdery Mildew of *Polygonum aviculare*. By C. E. Bessey.

10. Notes on the northern Species of *Celtis*. By N. L. Britton.

11. Remarks on some Species of *Quercus*. By N. L. Britton

12. Ohio Stations for Lea's Oak. By W. A. Kellerman.

13. Labels for living Plants. By W. A. Kellerman.

14. The introduced Species of *Lactuca* in Ohio. By A. D. Selby.

15. Some Peculiarities of the yearly Reappearance of *Plasmopara Cubensis* B. E C. on Cucumbers and Melons. By A. D. Selby.

16. What shall we regard as generic Types? By L. M. Underwood.

17. A Brief embryological Study of *Lactuca Scariola*. By J. W. T. Duvel.

18. The Position of the Fungi in the Plant System. By H. L. Bolley.

19. Some botanical Notes by an Entomologist. By A. D. Hopkins.

20. A Device for registering Plant-growth. By L. C. Corbett.

21. Notes on some of the Work of the Division of Botany of the United States Department of Agriculture. By O. F. Cook.

22. The Botanical Club organized by the Students and Teachers of the Michigan Agricultural College. By W. J. Beal.

23. Introduction and Persistence of *Cabomba Caroliniana* on the Grounds of the Michigan Agricultural College. By W. J. Beal.

24. Distribution of certain Swamp Plants in Kansas. By A. S. Hitchcock.

The following officers were elected: President, F. S. Earle, Auburn, Ala.; Vice-President, A. D. Selby, Wooster, Ohio; Secretary, F. E. Lloyd, New York City.

SULLIVANT DAY

Wednesday, August 23d, was taken for a bryological memorial to do honor to Sullivant and Lesquereux. Relatives and friends of these distinguished bryologists were present and portraits of both were loaned for exhibition. The tribute to Sullivant written by Dr. Gray for the Supplement to the Icones Muscorum was read by Professor Kellerman. Twelve North American mosses named for Sullivant were loaned from the Sullivant collection at Harvard, with the original drawings. Duplicates of these species from the Columbia University collection were also mounted for exhibition as well as microscopic slides of them made by Mrs. Britton, who gave a brief account of their subsequent history. Dr. Charles R. Barnes read his tribute to Lesquereux from the *Botanical Gazette*, and Dr. Arthur Hollick supplied information on the posthumous publication of his palaeontological work. Mrs. Britton gave a chronological record of the study of North American mosses since 1850, illustrated by tables and exhibited pamphlets and books which have been published since Lesquereux and James' Manual in 1884. Portraits of botanists whose names are perpetuated in those of American mosses were shown by E. A.

Rau, E. G. Britton and L. M. Underwood. Professor Kellerman exhibited a collection of mosses and drawings which had formerly been the property of Mr. Schrader, who made the drawings for Sullivant's Icones. Professor Underwood gave a brief account of the study of the Hepaticae, illustrated by books and pamphlets. The plates and specimens illustrating ten new species of hepatics from California, described by Marshall A. Howe, were exhibited by Professor F. E. Lloyd, who commended the morphological value of Dr. Howe's work.

Professor F. S. Earle read some notes on the moss flora of Alabama by Dr. Charles Mohr. Dr. A. J. Grout sent a set of the *Bryologist* and his revisions of the pleurocarpous mosses with some suggestions for a more satisfactory classification of them which were read by Mrs. Britton. Dr. George N. Best sent a set of his publications and Dr. Barnes exhibited a set of those of Renauld and Cardot and of Röll. Reports were received from the Sullivant Moss Chapter with a list of members from the Secretary, Mrs. Annie Morrill Smith. The Philadelphia Moss Chapter also sent a report and lists of books and specimens available for study at the Academy of Natural Sciences.

Among the specimens exhibited were several rare plants of Ohio, *Sullivantia Ohionis*, *Lonicera Sullivantii*, *Solidago Ohionis* and *S. Riddellii*, duplicates of which were distributed to all botanists present who cared to have them.

At the conclusion of the exercises Dr. C. E. Bessey offered a resolution advocating the founding of a bryological scholarship in memory of William S. Sullivant, and the resolution was accepted unanimously by those present.

Index to recent Literature relating to American Botany

Anderson, A. P. Rice Blast and a new Smut on the Rice Plant. Preliminary Report on Treatment for Rice Smut. Bull. S. C. Agric. Exper. Sta. 41: 1–31. Mr. 1899.

Andreas, J. Ueber den Bau der Wand und die Oeffnungsweise des Lebermoossporogons. Flora, **86**: 161–213. *f. 1–29. pl. 12.* 1899.

Atkinson, G. F. Studies on Reduction in Plants. Bot. Gaz. **28**: 1–26. *pl. 1–6.* 29 Jl. 1899.

Barnhart, J. H. Nomenclatural Notes.—II. Bull. Torr. Bot. Club, **26**: 376–380. 18 Jl. 1899.

Ilysanthes dubia (L.) and *Wulfenia Bullii* (Eaton), nom. nov.; notes on species in various genera, on dates of publication, etc.

Bicknell, E. P. Studies in *Sisyrinchium.*—II: Four new species from Michigan. Bull. Torr. Bot. Club, **26**: 297–300. 17 Je. 1899.

Sisyrinchium hastile, S Farwellii, S. strictum and *S. apiculatum*, sp nov.

Bicknell, E. P. Studies in *Sisyrinchium.*—III: *S. angustifolium* and some related species new and old. Bull. Torr. Bot. Club, **26**: 335–349. 18 Jl. 1899.

Sisyrinchium campestre, S. campestre Kansanum, S flaviflorum and *S. heterocarpum* are proposed by the author as new.

Brandegee, T. S. Island Flora Notes. Erythea, **7**: 70–71. 1 Jl. 1899.

Hemizonia Clementina sp. nov.

Clute, W. N. On the Distribution of some eastern Ferns. Linnaean Fern Chapter (Boston Meeting), 14–18. 1899.

Coulter, J. M. The Origin of the leafy Sporophyte. Bot. Gaz. **28**: 46–59. 29 Jl. 1899.

Daguillon, A. Observations morphologiques sur les feuilles des Cupressinées. Rev. Gen. de Bot. **11**: 168–204. *f. 1–41. pl. 5.* 15 My. 1899.

Davenport, G. E. Abnormal Forms and Hybridity in Ferns. Linnaean Fern Chapter (Boston Meeting), 1–11. 1899.

Davenport, G. E. *Acrostichum lomarioides* Jenman. Bull. Torr. Bot. Club, **26**: 318–319. 17 Je. 1899.

De Boissieu, H. Quelques mots sur les *Mitella.* Bull. Mens. Soc. Linn. de Paris, **13**: 105–109. 10 My. 1899.

Eastwood, A. New Localities for rare Californian Plants. Erythea, 7: 76–77. 1 Au. 1899.

Eaton, A. A. Notes on a peculiar *Botrychium*. Linnaean Fern Chapter (Boston Meeting), 25–30. 1899.

Farlow, W. G. Three undescribed Californian Algae. Erythea, 7: 73–76. 1 Au. 1899.
Dictyopteris zonarioides, *Spermothamnion Snyderae* and *Polyopes Bu'hiae* sp. nov.

Fletcher, J. Botanical Notes. Ottawa Naturalist, **13**: 75–76. Je. 1899.

Gilbert, B. D. On the Genera of Ferns: A Study of the Tribe Aspidieae. Linnaean Fern Chapter (Boston Meeting), 19–25. 1899.

Gilbert, B. D. Two new *Polypodia* from New Zealand. Bull. Torr. Bot. Club, **26**: 316–317. 17 Je. 1899.
Polypodium viride and *P. vulgare auritum* are proposed as new.

Grout, A. J. An interesting Variety of *Osmunda Claytoniana*. Linnaean Fern Chapter (Boston Meeting), 11–12. 1899.

Grout, A. J. A little-known Mildew of the Apple. Bull. Torr. Bot. Club, **26**: 373–375. *pl. 364*. 18 Jl. 1899.
Sphaerotheca mali (Duby) Burrill.

Halsted, B. D. The Influence of wet Weather upon parasitic Fungi. Bull. Torr. Bot. Club, **26**: 381–389. 18 Jl. 1899.

Harkness, H. W. Californian Hypogaeous Fungi. Proc. Cal. Acad. Sci. III. **1**: 241–292. *pl. 42–45*. 8 Jl. 1899.
New species in *Hymenogaster*, *Hydnangium*, *Octaviana*, *Hysterangium*, *Rhizopogon*, *Leucophleps* gen. nov., *Melanogaster*, *Hydnocystis*, *Genea*, *Balsamia*, *Hydnobolites*, *Hydnotrya*, *Pseudohydnotrya*, *Pachyphloeus*, *Myrmecocystis* gen. nov., *Geopora*, *Tuber*, *Piersonia* gen. nov., *Terfezia*, *Terfeziopsis* gen. nov., *Endogone*, *Sphaeria* and *Sporophaga* gen nov. with descriptions of 108 species new and old.

Harvey, F. L. Contributions to a Knowledge of the Myxogasters of Maine. Bull. Torr. Bot. Club, **26**: 320–324. 17 Je. 1899.

Heller, A. A. New and interesting Plants from Western North America. Bull. Torr. Bot. Club, **26**: 312–315. 17 Je. 1899.
Lepidium Idahoense, *L. simile*, *Ptelea rhombifolia*, *Microsteris diffusa*, *Crepis atrabarba* and *Grindelia Brownii*, sp. nov.

Hennings, P. *Xylariodiscus* nov. gen. und einige neue brasilianische Ascomycetes des E. Ule'schen Herbars. Hedwigia (Beiblatt), **38**: (63)–(65). 25 Ap. 1899.
New species in *Diplotheca Claviceps*, *Stictophacidium*, *Erinella*, *Gorgoniceps* and *Ombrophila*.

Hennings, P. Neue von E. Ule in Brazilien gesammelte Ustilagineen und Uredineen. Hedwigia (Beiblatt), **38**: (65)–(71). 25 Ap. 1899.

New species in *Ustilago, Urocystis, Polysaccopsis* n. g., *Uromyces, Puccinia, Uredo* and *Aecidium.*

Hennings, P. Fungi chilenses a cl. Dr. F. Neger collecti. Hedwigia (Beiblatt), **38**: (71)–(73). 25 Ap. 1899.

New species in *Dimerosporium, Melanomma, Montagnella, Cenangium* and *Septoria.*

Hill, E. J. Notes on Plants of the Chicago District. Bull. Torr. Bot. Club, **26**: 303–311. 17 Je. 1899.

Holm, T. *Juncus repens* Michx.—A morphological and anatomical Study. Bull. Torr. Bot. Club, **26**: 359–364. *pl. 363.* 18 Jl. 1899.

Holm, T. The Seedlings of *Jatropha multifida* L. and *Persea gratissima* Gärtn. Bot. Gaz. **28**: 60–64. *f. 1–6.* 29 Jl. 1899.

Howe, M. A. The Hepaticae and Anthocerotes of California. Mem. Torr. Bot. Club, **7**: 1–208. *pl. 88–122.* 5 Au. 1899.

Riccia Americana, R. Campbelliana, Clevea hyalina Californica, Sphaerocarpus cristatus, Cephalozia divaricata scabra and *Blepharostoma arachnoideum* sp. et var. nov.

Jeffrey, E. C. The Development, Structure and Affinities of the Genus *Equisetum.* Mem. Boston Soc. Nat. Hist. **5**: 155–190. *pl. 26–30.* Ap. 1899.

Klebahn, H. Kulturversuche mit heterocischen Rostpilzen. Zeitschr. für Pflanzenkranheiten. **9**: 88–99. *f. 3, 4.* 6 My. 1899.

Cultures of *Melampsora.*

Lamb, F. H. Root Suckers on the Douglas Fir. Bot. Gaz. **28**: 69–70. 29 Jl. 1899.

Lemmermann, E. Das Genus *Ophiocytium* Naegeli. Hedwigia, **38**: 20–38. *pl. 3, 4.* 28 F. 1899.

Lloyd, C. G. Mycological Notes. No. 3. 18–24. Cincinnati, O. Ap. 1899.

Notes on various species of fungi including *Bolbitius sordidus* sp. nov.

MacBride, T. H. Botany: How much and when? Pp. 1–11. 1899.

MacMillan, C. Observations on *Nereocystis.* Bull. Torr. Bot. Club, **26**: 273–296. *pl. 361, 362.* 17 Je. 1899.

Magnus, P. Ueber die Gattung *Uropyxis* Schroet. Ber. Deutsch. Bot. Ges. **17**: 112–120. *f. 1, 2.* 26 Ap. 1899.

Meehan, T. *Echinocactus setispinis.* Meehan's Monthly, **9**: 81–82. *pl. 6.* Je. 1899.

Meehan, T. *Bidens connata.* Meehan's Monthly, **9**: 97–98. *pl. 7.* Jl. 1899.

Meehan, T. Contributions to the Life History of Plants. No. XIII. Proc. Acad. Nat. Sci. Phila. 1899: 71–117. *f. 1–5.* 1899.

Various morphological and biological notes relating to a variety of plants.

Nelson, A. The western Species of *Aragallus:* Critical Notes and Novelties. Erythea, **7**: 57–64. 1 Je. 1899.

Contains descriptions of several new species and varieties and a few changes in nomenclature.

Nelson, A. New species in *Oreocarya* and its Allies. Erythea, **7**: 65–70. 1 Je. 1899.

Oreocarya caespitosa, O. flavoculata, O. flavoculata spatulata, O. affinis perennis, O. longiflora, Cryptanthe ramulosissima, C. muriculata montana and *Allocarya Hendersoni* are proposed as new.

Nelson, A. New Plants from Wyoming—IX. Bull. Torr. Bot. Club, **26**: 350–358. 18 Jl. 1899.

Ranunculus alpeophilus, Arenaria pinetorum, Cheiranthus aridus, Draba andina (Nutt.), *Arenaria verna equicaulis, Polemonium Haydeni, P. mellitum* (Gray), *Pentstemon Crandallii, P. Coloradoensis, Grindelia perennis, G. erecta* and *Gnaphalium angustifolium,* new species, varieties, and names; *Nacrea,* gen. nov. with one species, *N. linata* A. Nelson.

Nelson, E. Revision of the western North American Phloxes. Pp. 1–35. 1 Je. 1899.

Includes *P. Covillei, P. Piperi, P. cernua, P. virida, P. viscida, P. tenuifolia, P. hirsuta, P. lanceolata, P. aspera* sp. nov. and several varieties raised to specific rank.

Nêmec, B. Ueber Zellkern and Zelltheilung bei *Solanum tuberosum.* Flora, **86**: 214–227. *pl. 13, 14.* 20 My. 1899.

Osterhout, G. E. Notes on Colorado Plants. Erythea, **7**: 71–72. 1 Jl. 1899.

Peckholt, T. Medicinal Plants of Brazil. Pharmaceutical Archives, **2**: 92–100. My. 1899.

Peirce, G. J. The Nature of the Association of Alga and Fungus in Lichens. Proc. Cal. Acad. Sci. III. **1**: 207–240. *pl. 41.* 5 Je. 1899.

Pollard, C. L. The Genus *Achillea* in North America. Bull. Torr. Bot. Club, **26**: 365–372. 18 Jl. 1899.

Achillea Californica, A. gigantea and *A. Pecten-Veneris,* sp. nov.

Radais, M. On the Blight of Sorghum. Bot. Gaz. **28**: 65–68. 29 Jl. 1899.

Robertson, C. Flowers and Insects.—XIX. Bot. Gaz. **28**: 27–45. 29 Jl. 1899.

Roth, G. Übersicht über die Familie der Hypnaceen. Hedwigia (Beiblatt), **38**: (3)–(8). 28 F. 1899.

Rothrock, J. T. The Black Spruce (*Picea nigra* Link.). Forest Leaves, **7**: 40. Je. 1899. [Illust.]

Schrenk, H. von. A Disease of *Taxodium* known as Peckiness, also a similar Disease of *Libocedrus decurrens*. Rep. Mo. Bot. Gard. **11**: 1–55. *pl. 1–6.* 3 Je. 1899.

Schrenk, H. von. A sclerotioid Disease of Beech Roots. Rep. Mo. Bot. Gard. **10**: 61–70. *pl. 55, 56.* 1899.

Scribner, F. L. New Species of North American Grasses. Circ. U. S. Dept. Agric. (Div. Agrost.) **16**: 1–6. *f. 1.* 1 Jl. 1899.
New species in *Andropogon*, *Puccinellia*, *Poa*, *Dactyloctenium* and *Panicum*.

Scribner, F. L. Recent Additions to Systematic Agrostology. Circ. U. S. Dept. Agric. (Div. Agrost.) **15**: 1–10. *f. 1–5.* 14 Jl. 1899.

Selby, A. D., & Duvel, J. W. T. Sources of the Ohio Flora. Proc. Columbus Hort. Soc. **14**: 35–59. Mr. 1899.

Smith, J. G. The Velvet Bean (*Mucuna utilis*). Circ. U. S. Dept. Agric. (Div. Agrost.) **14**: 1–5. *f. 1–3.* 1899.

Smith, J. G. Grazing Problems in the Southwest and how to meet them. Bull. U. S. Dept. Agric. (Div. Agrost.), **16**: 1–47. *f. 1–9.* 1899.

Spegazzini, C. Nova Addenda ad Floram Patagonicam. Anales Soc. Cien. Argentina, **47**: 161–177. Ap. 1899.

Stone, G. E., & Smith, R. F. The Asparagus Rust in Massachusetts. Bull. Mass. Exp. Sta. **61**: 1–20. *pl. 1, 2.* Ap. 1899.

Sturtevant, E. L. Varieties of Corn. Bull. U. S. Dept. Agric. (Exp. Sta.) **57**: 1–108. 1899. [Illust.].

Vail, A. M. Notes on *Covillea* and *Fagonia*. Bull. Torr. Bot. Club, **26**: 301–302. 17 Je. 1899.
Covillea tridentata nom. nov. for *Zygophyllum tridentatum* Moç. & Sessé.

Williams, C. L. The Origin of the karyokinetic Spindle in *Passiflora coerulea* Linn. Proc. Cal. Acad. Sci. III. **1**: 189–206. *pl. 37–40.* 15 Ap. 1899.

[This Index is reprinted each month by the Cambridge Botanical Supply Company in card catalogue form.]